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Analysis of Media Coverage of Selected Food Safety Events on the Demand for the Recalled Products

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ANALYSIS OF MEDIA COVERAGE OF SELECTED FOOD SAFETY EVENTS ON THE DEMAND FOR THE RECALLED PRODUCTS

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Dedicated to my parents……

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ABSTRACT

The major focus of this study was to identify the linkage between information and consumer behavior and to examine the role that a new media index played in the identifying the tone of news stories. Past studies have relied on using the number of media stories but, this study tests a new approach, i.e., in order to analyze the effect of information by incorporating the sentiment indices. These indices were created based on the tone of the news story. The results from sentiment indices were compared to the results from the information index.

Barten's Synthetic model (BSM) was used to capture the demand interrelationships and a Polynomial Inverse Lag model (PIL) was utilized in order to identify the size and length of change in demand. A time series data set, comprised of household purchases from 2008 to 2010, was created with information obtained from Nielsen HomeScan panel data.

This study investigates three cases of food safety incidents, in which each case presents a unique scenario of food safety incidents. The first case is related to the PCA peanut butter recall of 2009, the second case investigates the refrigerated cookie dough recall of 2009 and the third case considers the effect of the Gulf oil spill on the demand for meat products and, in particular, on the demand for frozen seafood. This study was able to confirm significant changes in the demand of affected products in the post-event period.

Furthermore, the study brings important contributions to the existing literature. To our knowledge, this is the first study which utilizes a natural word processing algorithm to identify the sentiment of the news story related to a particular food safety incident and that actually assigns a *sentiment score* to the story. The comparison between the media index, created by using the number of news stories related to the particular event, and the sentiment index reveal that the sentiment index exhibits a stronger effect on the demand for the products tested. The

results from sentiment indices show that it can be used as a feasible alternative to the currently used media indices to measure the information effect on demand.

CHAPTER 1. INTRODUCTION

1.1 Introduction

With the rise of the modern news media, by creating a well-informed consumer base, and along with the increase in the number of recent food recalls, the food industry and its image have been impacted as of late. According to a Food Marketing Institute study, more than 80 percent of consumers expressed confidence in the safety of the food that they purchased in grocery stores in 2006, but by 2007 this percentage had fallen to 66 percent (FMI, 2008). Even though efforts have been made to improve the quality and integrity of the food supply chain, food safety has been increasingly perceived as an important health risk by consumers. Consumers' trust in the food supply is being further eroded by the increase in the number of food recalls in recent years (from 240 recalls in 2006 to 565 recalls in 2008, an increase of 135 percent) (Food Industry Report, 4/14/09).

Regulatory agencies (USDA, FDA, and CDC, along with other federal and state agencies) in the U.S. are charged with the maintaining the safety of the food supply chain in the U.S. In the event of a food safety incident, appropriate measures are taken as to coordinate the exchange of pertinent information between the different agencies, the media and the public in order to take the appropriate steps to reduce the impact of the incident. Consumers expect the government to ensure the safety of food available for consumption; failure to do so damages consumer confidence (de Jonge, et al., 2008). Therefore regulatory agencies have been entrusted with more power than they previously held with the Food Safety Modernization Act (FSMA) of 2011.

A higher level of consumer trust in institutions and organizations leads to a higher level of consumer confidence (de Jonge, et al., 2008). However, there still remain a significant number of people who are exposed to poor quality food on a yearly basis. Several studies have estimated the number of food-borne illnesses resulting from breaches in the food safety chain that result in hospitalizations and even deaths in the U.S. In one of the most widely cited studies, the U.S. Centers for Disease Control (CDC) estimated that 76 million people contract food-borne illnesses each year, resulting in 325,000 hospitalization and 5,000 deaths in the U.S. (Mead, et al., 1999). Unknown agents account for the majority of the reported incidents—62 million illnesses, 265,000 hospitalizations, and 3,200 deaths; however, known pathogens are responsible for an estimated 14 million illnesses, 60,000 hospitalizations, and 1,800 deaths. Out of these 1,800 deaths, salmonella, listeria, and toxoplasma are responsible for 1,500 deaths, i.e., more than 75% of food borne deaths are caused by known pathogens (Mead, et al., 1999). From 1998-2008, the CDC received 13,405 reported cases of foodborne disease outbreaks, which resulted in 273,120 reported cases of illness, 9,109 hospitalizations, and 200 deaths, with an annual average of 1,219 outbreaks, 24,829 illnesses, 828 hospitalizations, and 20 deaths (Gould, et al., 2013). Around the same reporting period, the Center for Science in the Public Interest (CSPI) identified 838 food borne illness linked to seafood, 684 to produce, 538 to poultry, 428 to beef and 200 to pork (Tian, 2009). Table 1 lists the reported foodborne outbreaks, illnesses, hospitalizations, and deaths for a more recent period.

Table 1: Foodborne Disease Outbreaks 2008, 2009-2010 and 2011-2012

	Year		
	2008	2009-2010	2011-2012
Outbreaks Reported	1,034	1,527	1,632
Cases of illness	23,152	29,444	29,112
Hospitalizations	1,276	1,184	1,750
Deaths	22	23	68

Source: Foodborne Disease Outbreak Surveillance System 2008, 2009-2010, 2011-2012

Studies have also estimated the economic and societal cost of foodborne illnesses to the U.S. economy. A study by Vogt (2005) estimated that food-borne illnesses cost the U.S. economy at least $6.9 billion a year. The cost includes medical expenses and loss of productivity due to missing work, among other costs (Vogt, 2005). A 2007 study estimated that the cost ranged from $455 billion to $1.4 trillion annually, and a 2012 study estimated the annual health related cost to be $77.77 billion (Roberts, 2007, Scharff, 2012). The estimated costs each year point to the extent of losses suffered by U.S. economy from food borne illnesses.

Contaminated foods also negatively impact consumer well-being. In the October 4, 2009 edition of the New York Times, reporter Michael Moss introduced readers to Stephanie Smith, a children's dance instructor from Minnesota who was partially paralyzed from eating hamburgers contaminated with E. coli O157:H7. This story was widely circulated in the media, and Stephanie sued Cargill, the hamburger meat producer, for $100 million (Flynn, 2009). The media coverage of the food safety incident not only cast the firm in a bad light, but also increased consumers' perceived risk, leading to a decline in the demand for ground beef (Swinnen, et al., 2005). Research is revealing more and more the influence media coverage has in inducing changes in perceived health risks and ultimately affecting the demand for the associated food product (Swinnen, et al., 2005). A strong public outcry has also forced the government to adopt regulations governing the import and export of the commodities affected, thus impacting trade (Buzby, 2001).

1.2 General Background

Processed foods make up a large percentage of the modern diet in the developed world, so a food safety event involving any processed foods will receive significant publicity. However, information about an event can be misrepresented by media outlets or misinterpreted by consumers, which might lead a product to suffer losses even though it is not involved in the food safety event. The extensive reach of media outlets allows any news story about a food safety event to inflict extensive losses for the demand of the product involved. It also has an impact on close substitutes, which may experience a ‘spillover effect’ and suffer losses in the demand of the product. A food safety event can also be large enough to affect demand at both the national and the international levels. The effect of information varies with the way it has been presented, i.e. the positive information will have a different effect from the negative information.

This study presents three unique opportunities in attempting to understand a consumer’s response to food illness outbreaks. The first food safety event considered in this study occurred in 2009, when the U.S. witnessed the largest peanut butter recall in its history. The CDC first started noticing the increase in salmonella related illnesses in the beginning of October 2008. On January 9, 2009, the Minnesota health department reported salmonella in the King Nut peanut butter containers supplied by Peanut Corporation of America (PCA). On January 16, 2009, the PCA announced a peanut butter and paste recall (CDC, 2009). The extent of the recall was unprecedented; more than 2,100 products containing PCA supplied peanut butter paste, involving more than 200 companies were affected. On February 20th, PCA filed for chapter 7 bankruptcy (FDA, 2009). Even though the recall did not include any major peanut butter brands, it affected all the other peanut butter brands with an estimated decrease of 25 percent in sales (Martin and Robbins, 2009). Figure 1 shows a decline in sales of top peanut butter brands. The food industry speculated that heavy economic losses amounting to almost $1 billion were encountered (Doering, 2009). The Harvard Opinion Research Program conducted a survey after the PCA peanut butter recall and found that 93% of Americans had heard about the recall. Additionally, they found that one in four respondents believed that all the major national peanut butter brands were involved in the recall (HSPH, 2009). The survey also found an overall loss of confidence among consumers regarding food manufactures and government inspection agencies (HSPH, 2009).

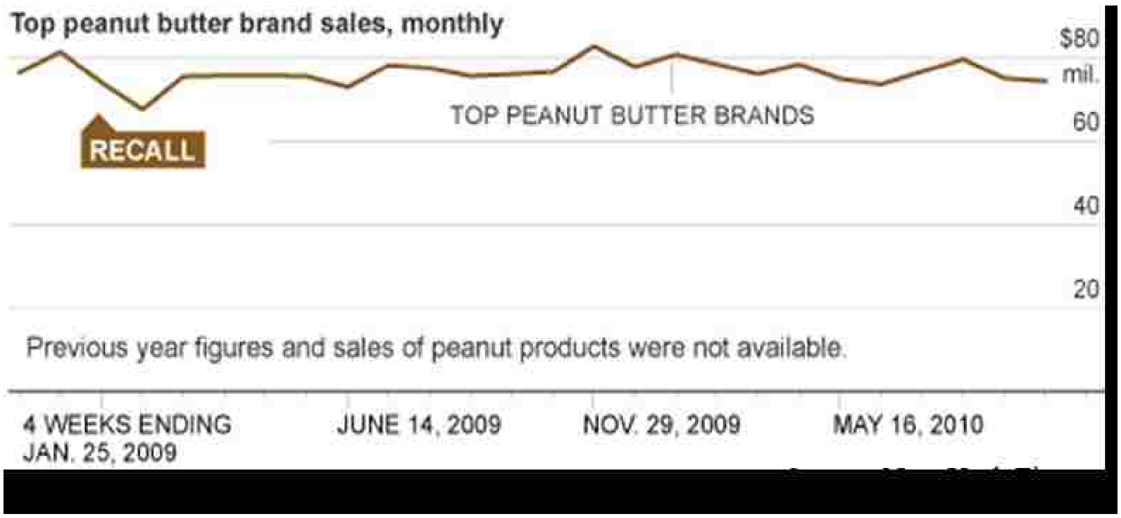

Figure 1: Monthly Sales of Top Peanut Butter Brands after the Recall

The second food safety event also occurred in 2009, when Brand1, a well-known and longstanding brand name in the food industry, enjoying the largest refrigerated cookie dough market share, was implicated in the 2009 cookie dough recall. Immediately after Brand1 cookie dough was implicated in an FDA investigation—the CDC reported that 76 persons from 31 states had been infected due to the outbreak—Brand1 announced it had suspended operations and voluntary recalled its products.

Figure 2 shows states affected due to recall. The recall was applied only to the specified Brand1 refrigerated cookie dough products, which included refrigerated cookie dough bars, cookie dough tubs, cookie dough tubes, and seasonal cookie dough (FDA, 2009). This is the first study to analyze this food safety event, and the first to test the effect of information sentiment on the demand at the brand level.

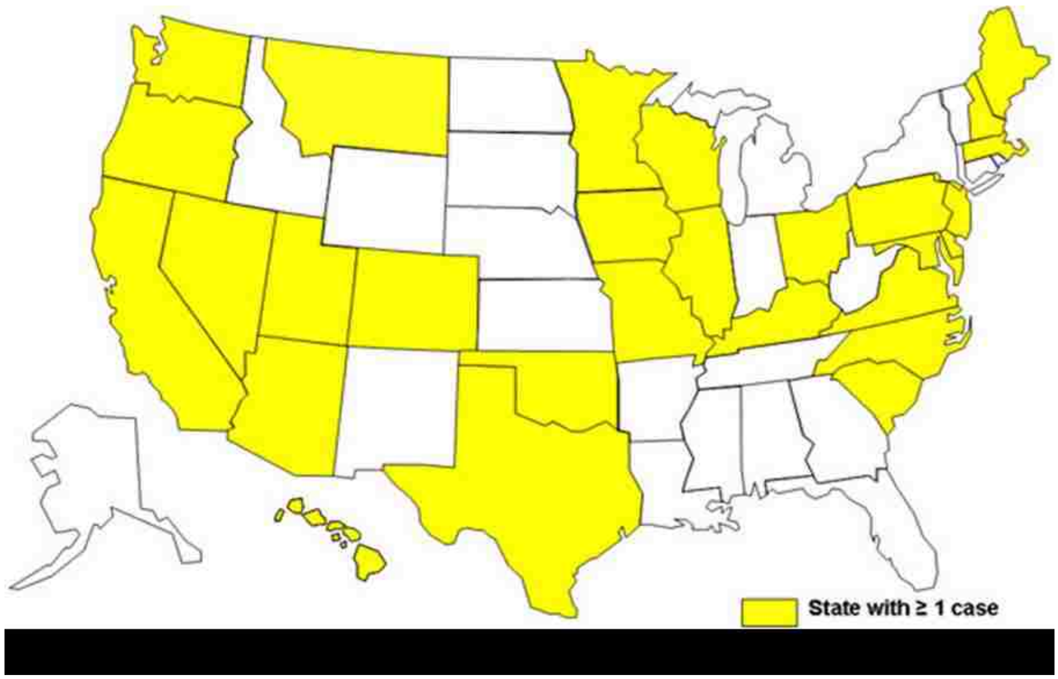

Figure 2: Multistate E. Coli Outbreak Linked to Raw Refrigerated Cookie Dough

The third food safety event occurred on April 20, 2010, when an offshore oil rig located about 50 miles off the southeast coast of Louisiana exploded. Out of the 126 people on board the Deepwater Horizon, seventeen were injured and eleven went missing. Two days later, on April 22nd, the oil rig sunk and a five mile long oil slick appeared on the water's surface. On April 24th, the Coast Guard confirmed that the oil was leaking from two places, at an estimated rate of 1,000 barrels a day, which increased to 5,000 barrels a day on April 28th. The depth of the leak at 5,000 feet made it impossible for a human crew to fix the leak. On June 18th, it was estimated that oil was leaking at a rate of about 60,000 barrels a day into the Gulf of Mexico.

The oil spill created doubts about the safety of seafood harvested off the coast, and the affected waters were closed for fishing and seafood harvesting. On September 19th the oil spill officially ended, and tests were conducted in phases so as to make sure that the seafood was safe for human consumption. After the waters were again opened up for fishing, consumers still had their reservations about the safety of seafood products harvested from the gulf because of the large amount of chemical dispersants used to help break down the oil.

1.3 Problem Statement

This study investigates three food safety related incidents, the PCA peanut butter recall, the refrigerated cookie dough recall and the Gulf oil spill incident. Each incident presents a unique situation. The first food safety incident is related to PCA peanut butter recall of 2009. As mentioned earlier, none of the major peanut butter brands were included in the recall. However, the way information about the PCA peanut butter recall was represented by media outlets, lead consumers to misinterpret the involvement of major peanut butter brands in the recall. The misinformation by media and misinterpretation by consumers translated into losses for peanut butter brands. The situation provides a unique opportunity to investigate the effect of information on the demand for peanut butter, although none of the brands were involved. The study investigates the incident in a system of equations approach followed by a single equation approach. The nature of the dataset limits us from identifying the products which contained peanut butter paste supplied by the PCA, and hence studying the effect of recall on the products which were actually involved in the recall.

The refrigerated cookie dough recall of 2009 provides another unique situation. The recall was limited to only the *Brand1* brand of refrigerated cookie dough. A recall restricted at the brand level involves a small group of products, comprised of other brands for a system of equations analysis approach. Brand1 was not on store shelves during the period of the recall event, which, in turn, restricts our ability in this study to test the effect on demand for both the pre-event and post-periods.

The Gulf oil spill of 2010 offers another unique situation. The coverage about the oil leak and the use of chemical dispersants, along with fishing water restrictions and warnings about consuming seafood from the government, made consumers cautious about eating seafood. The nature of the dataset limits the ability of this study to identify the fresh meat and fresh seafood products. This study examines the demand relationship between frozen seafood and other frozen meat products.

1.3.1 Objectives

The overall goal of this study was to empirically identify the effect of information sentiment on the demand for products involved in a food safety incident. To achieve this objective, a sentiment index was generated after analyzing the tone of news stories published. Usually studies in the past have used media indices created by using the number of stories about food safety. In this study we compare the results from sentiment indices to those results obtained from the media indices created by using number of stories related to food safety. In the past, studies have argued against using separate positive and negative media indices citing an argument that any information only heightens consumer awareness about the food safety incidence and positive and negative information does not produce varying results. This argument is tested here using positive and negative sentiment indices created by using sentiment analysis.

This study also identifies the demand relationship between the products categories used for the analysis. Past studies identifying the shock to the demand due to food safety incident have used dummy variables in interaction with media indices. Along with incorporating a dummy and media index interaction variable, this study also examines structural change in the demand for the products involved by comparing results from pre-event period to post-event period. The demand system approach allows for the identification of the long term effect of information has on the demand for products, however it does not describe size of the effect on any time scale. This study also aims to identify the size and length of information effect on the demand of the products involved in the food safety incident. The specific objectives pertaining to each case are presented below.

1.3.1.1 PCA peanut butter recall

- To estimate the effect of information on the consumer demand for peanut butter after 2009 PCA peanut butter recall.
- To identify the Polynomial Inverse Lag (PIL) structure to determine the size of reduction in consumption caused due to information.
- To identify the time length of reduction in consumption of peanut butter.

1.3.1.2 Refrigerated Cookie Dough Recall of 2009

- To estimate the change in consumer demand relationships for the refrigerated cookie dough market after a food safety outbreak was announced.
- To estimate the spillover effect of information on the refrigerated cookie dough brands during the food safety incident.
- To estimate the own-price and cross-price effects across refrigerated cookie dough brands after the recall period.

1.3.1.3 Gulf Oil Spill event of 2010

- To estimate the changes in consumer demand relationships for frozen and fresh seafood and other meat products.
- To estimate the effect of food recall information on the demand of frozen meat and seafood.

- To estimate the effect of the 2010 Gulf oil spill event on the demand for frozen seafood during and after the Deepwater Horizon oil spill.
- To investigate the effect of positive and negative information on the demand for frozen seafood during and after the Deepwater Horizon oil spill.

1.4 Organization of Study

The study is organized in the following order. First, an introduction section detailing the background and problem statement for this study is offered. The introduction also details the objectives of the study. The second chapter offers the literature review on food safety incidents and consumer demand, media indices and information decay process used in the past studies. Chapter three illustrates those methods used for the estimation process and data samples used in the study. Chapter four explains the results obtained after analyzing the food safety incidents studied. The results section discusses the effect that information has on the demand of the products studied. Chapter five presents the conclusions and implications for this study.

CHAPTER 2. LITERATURE REVIEW

2.1 Consumer Demand and Food Safety Events

Currently, less than two percent of the U.S. population is engaged in agricultural production, and the average consumer has little knowledge of the agricultural and food production systems. As a result, consumers often rely on mass media for relevant information about food safety (Kalaitzandonakes, et al., 2004). It has been argued that mass media can play an important role in building or undermining consumer confidence in the safety of foods, particularly because consumers have limited ability to assess food safety prior to consuming it (Verbeke and Viaene, 1999).

The impact of mass media not only influences the consumer, but, inadvertently, the producers, as the demand for implicated food products have generally gone down with a food recall or food illness outbreak. For example, consumers responded to the Food and Drug Administration's (FDA) warnings to avoid eating spinach because of possible E. Coli O157:H7 contamination in September of 2006. Using an Almost Ideal Demand System (AIDS) model, Arnade et al. (2009) found that during the recall, spinach expenditures fell, and consumers turned to other leafy greens as substitutes (Arnade, et al., 2009).

Similar outcomes have been found during other food recalls. Schlenker and Villas-Boas (2008) examined the reactions of consumers and financial markets to the health warnings about Bovine spongiform encephalopathy (BSE) (i.e. mad cow disease). They used product level scanner data and found a significant reduction in beef sales (Schlenker and Villas-Boas, 2009). Marsh *et al.* (2004) investigated the impact of meat product recall events on the demand for beef, pork, poultry, and other complementary goods in the United States. Findings from the study indicated that the Food Safety Inspection Service's announcement of the meat recalls from

1982–1998 significantly impacted the demand for beef, pork, poultry and other complementary goods in the United States (Marsh, et al., 2004).

Research has also found that food safety outbreaks may or may not have an impact on the price of products. Bakhtavoryan et al. (2012) tested for significant changes in the compensated price elasticity's of different peanut butter brands during the pre-recall and post-recall periods (after one brand was linked to food-borne illnesses in 2006). While they found significant differences in compensated cross-price elasticities during the pre-recall and post-recall periods, a study using data from another peanut butter outbreak (in 2009) found that after the peanut butter paste recall of April 2009, slowed retail purchases for products containing peanut butter but returned to previous-year levels within just a few months. The study also found that the recall did not have a lasting impact on processed peanuts (Wittenberger and Dohlman, 2010).

Unfortunately, food recalls may not implicate just one brand in particular. This may confuse consumers and impact the consumers' perception of products in the same product category. Bakhtavoryan *et al*. (2012) estimated a change in consumer demand after the peanut butter recall of 2006, and found that an increase in bad publicity and information about a certain brand or product category could transfer a negative perception on other commodities. Bakhtavoryan *et al*. (2012) estimated a change in consumer demand after the peanut butter recall of 2006, and found evidence of a spillover effect after the recall. The study also concluded that the recalled brand recovered from the crisis, and its efforts to restore the firm's image were successful (Bakhtavoryan, et al., 2012). Spillover effects refer to the extents that a message influences beliefs related to attributes that are not contained in the message (Ahluwalia, et al., 2001).

Media plays an important role in reminding consumers of a food safety recall—it has the potential to magnify the impact of an event on the industry experiencing the crisis by inducing change in the perceived public risk. Consumers who remember a food safety incident are not necessarily less optimistic relative to consumers who do not remember the food safety incident, but they can be more pessimistic (De Jonge, et al., 2007). Various studies have accounted for media's impact on consumer confidence (De Jonge, et al., 2010, Kinsey, et al., 2009, Tansel, 1993). Most have shown that media coverage has a negative impact on consumer risk perceptions (Frewer, et al., 2002, Liu, et al., 2004, Siegrist and Cvetkovich, 2001). Liu et al. (2004) indicated that effects of positive and negative information to adjustment of consumption and risk perception were asymmetric over time, using the same data, Smith et al. (1988) found that positive media generally had a lag period.

The media coverage of a food safety crisis affects demand for the associated food product by increasing the perceived risk of consuming that food product (Swinnen, et al., 2005). In the October 4, 2009 edition of the New York Times, reporter Michael Moss introduced readers to Stephanie Smith, a children's dance instructor from Minnesota who was partially paralyzed from E. coli O157:H7 which Smith contracted after eating hamburgers produced by Cargill. This story was quickly circulated in the media. Stephanie sued Cargill for $100 million (Flynn, 2009). Other studies (Kinsey, et al., 2009) have also shown that food recalls and food safety events have the potential to disrupt a consumer's life. To better assist and prepare consumers for these kinds of situations, it is necessary to gain a better understanding of consumer attitudes and concerns (Degeneffe, et al., 2006).

There are various determinants, which shape consumer confidence. De Jonge et al. (2007) stated that consumer confidence in the safety of food consists of two dimensions -

optimism and pessimism. The notion of optimism and pessimism are distinct and they are influenced by different determinants, and the consumers' memory of food safety incidents affected the consumers' level of optimism and pessimism differently. (De Jonge, et al., 2007). Trust and consumer confidence in the safety of product groups act as the basis for optimism about the safety of food, while pessimism is affected by individual differences like food allergies and trait worry. The results from the study indicated that optimism and pessimism about food safety was developed from consumer trust in regulators and actors in the food chain. The study also found the perceived safety of meat and fish, and not any other product category helped develop consumer trust.

Studies have shown that people accept negative information presented by media more quickly than the positive information (Siegrist and Cvetkovich, 2001, Verbeke and Ward, 2001). Liu et al. (2004) conducted a case study of milk contamination so as to demonstrate the demand adjustment process to a temporarily unfavorable shock. The results from the study indicated that the effects of positive and negative information to adjustment of consumption and risk perception were asymmetric over time. They also indicated that positive media had a lag period and positive media coverage could help reduce the loss of consumption (Liu, et al., 2004).

Verbeke and Ward (2001) showed that TV coverage of health risk related to meat consumption had a negative impact on meat consumption. The study also showed that the higher negative TV coverage might have outweighed the industries' advertising efforts to increase the consumption. In 1988, a study by Smith et al. (1988) sought to estimate lost sales following a food contamination incident of heptachlor contamination of fresh fluid milk in Oahu, Hawaii. The study found that the media coverage following the milk contamination incident had a significant effect on milk purchases, and it also found that the negative media coverage had outweighed the positive media coverage (Smith, et al., 1988).

Swinnen et al. (2005) noted two kinds of media namely quality media and popular media. Popular media results from competing media outlets that are intensely covering popular events like food safety recalls. It is characterized by intense coverage in the early periods, followed by a rapid loss of interest. The competition and selectivity of reporting leads to bias in the treatment of the situation and a development of a mostly negative tone (Swinnen, et al., 2005). Studies have been conducted to estimate the impact of negative information and positive information (Smith, et al., 1988, Verbeke and Ward, 2001). In another study, Ten Eyck (2000) investigated how reporters marginalized issues related to food safety, as mass media coverage tends to cluster around crisis situations. The study collected media stories from 1986-1997 to study the effect of the information. In addition, the article investigated two food safety issues and found that media coverage tended to cluster around the food safety crisis (Ten Eyck, 2000). Swartz and Strand (1981) estimated the effect of imperfect information on demand by investigating the impact of media coverage on the demand of Kepone contaminated oysters from the James River in Virginia. The results from the study demonstrated that contamination reports affect non-contaminated products (Swartz and Strand, 1981).

2.2 Media Index

In order to study media impact, researchers have often created a media index. For example, a study by Piggott and Marsh (2004) developed an empirical framework to investigate whether food safety information surrounding beef, pork and poultry had an impact on the consumption of meat in the United States. The study used a LexisNexis' academic version tool to search the top fifty newspapers in the country for any news about food recall events using keywords to identify the incident. The data series collected was used to create a food safety index capable of measuring the impact of information on the consumption of meat in the United States. The study found that negative publicity has a *statistically* important own-commodity and cross-commodity impact on the demand for meat in the U.S. The study also found that the average impact of these effects are *economically* small over the time period studied (Piggott and Marsh, 2004).

Marsh et al. (2004) used the Food Safety Inspection Service's meat recall events and the newspaper reports over the period of 16 years to develop beef, pork and poultry recall media indices. A study by Burton and Young (1996) used an indicator created by the count of newspaper articles that mentioned BSE (i.e. mad cow disease) and incorporated it in the Almost Ideal Demand System (AIDS) model for meat demand. The indicator was used in two ways, the number of articles per quarter to measure the transitory effect on meat expenditures, and the cumulative number of articles as a modifier for long-run relationships. The study found that the media coverage for BSE had a significant effect on the allocation of consumer expenditure among beef and other meat products (Burton and Young, 1996).

Different approaches have attempted to create a media index so as to analyze the effect of media coverage. Tansel (1993) used dummy variables to measure the effect of anti-smoking campaigns on Turkish cigarette demand (Tansel, 1993). A study by Smith et al. (1988) used actual newspaper article counts, marked as either positive or negative, to analyze the impact of media coverage on a specific event (Smith, et al., 1988). Chang and Kinnucan (1991) used a cumulative number of media stories to analyze the impact of cholesterol information on the consumption trends of fats and oils (Chang and Kinnucan, 1991). Verbeke and Ward (2001) developed a media index as a measure of television coverage and negative press related to fresh meat issues. The study observed media stories from TV coverage and kept track of positive and negative stories separately. It found that most of the media coverage was based on negative stories and that the correlation between negative stories and positive stories was 0.98, making it impractical to weigh the negative and positive stories separately (Verbeke and Ward, 2001). The study also included a five period lag for TV stories, thus effectively extending the interval to a period of 6 months for the negative press.

In the case of linking egg cholesterol to adverse health effects, Brown and Schrader (1990) created an information index called the *cholesterol index*. This is the sum of articles supporting the linkage between cholesterol and disease minus the sum of articles questioning the link. The study found that information about linkage between cholesterol and heart disease had led to reduced egg consumption (Brown and Schrader, 1990).

2.3 Information Decay

After estimating the impact of food recall publicity on consumption, it is also important for the food industry to identify the duration to which the incident lingers with consumers. Several studies have explored the duration of consumer recall regarding a news story published in a media outlet. In a study analyzing the effects of media coverage about avian influenza on consumer behavior, Beach et al. (2008) calculated the number of news articles published during the time period and used a polynomial inverse lag structure to create a media index. The study found that additional information from newspaper reports reduced fresh poultry consumption, but the reductions were not permanent and eventually lessened (Beach, et al., 2008). In a case study that estimated the impact of publicity related to chicken contamination, Dahlgran and Fairchild (2002) developed an inverse demand model and used a non-linear regression analysis for the estimation. The study found that consumers respond to negative information about food consumption and although adverse information affects demand, the effect is small and temporary (Dahlgran and Fairchild, 2002).

Dahlgran and Fairchild (2002) also calculated the rate at which information decays. A study by Watt et al. (1993) proposed that fundamental concepts in agenda-setting are related to a simple cognitive memory decay process. The study estimated the levels of declining accumulated coverage by applying an exponential decay function to the prominence of daily television coverage(Watt, et al., 1993). As early as 1885, Ebbinghaus found that memory decays exponentially, with memory decay being rapid at the beginning of the process and slower as time progresses (Ebbinghaus, 1913). In an effort to describe the memory retention in mathematical form, Rubin and Wenzel (1996) tested 100 different retention functions for 210 datasets. None of the functions were able to fit all datasets, they found four functions which were able to fit most of the datasets (Rubin and Wenzel, 1996). Chessa and Murre introduced a memory model called the Memory Chain model(Chessa and Murre, 2004).

Chern and Zuo (1995) created a third degree polynomial information index in their study about the impacts of fats and cholesterol information on consumer demand. The cubic index takes into consideration the effect of news carryover and the decay effect (Chern and Zuo, 1995). Kim and Chern (1997) extended on the cubic model developed by Chern and Zuo (1995) and proposed an index with geometrically declining weight function. In the study, authors compared the information indices incorporating decay effect which displayed very different results from the indices using time trend (Kim and Chern, 1997). Kim and Chern (1999) used the geometrically declining weight function to estimate the effect of health information on the demand for fats and oils in Japan. Authors found that increasing health information had reduced the consumption of fats and oils except for vegetable oil (Kim and Chern, 1999). Radwan et al.

(2008) studied the effect of food safety information on meat demand in Spain. They incorporated both the cubic index and geometrically declining index in their study(Radwan, et al., 2008).

A study by Watt et al. (1993) proposed that fundamental concepts in agenda-setting are related to a simple cognitive memory decay process. The study estimated the levels of declining accumulated coverage by applying an exponential decay function to the prominence of daily television coverage(Watt, et al., 1993).

Though the exponential decay function has been used most widely, there are other forms of functions available. Wickelgren (1972) characterized the trace of long term memory storage theory using two properties, strength and resistance of memory. The author listed a few other memory retention functions such as linear decay, exponential power decay, logarithmic decay and power function decay (Wickelgren, 1972). Wickelgren (1970) found that an exponential function can be used for short term memory trace. In another study for long term memory, the author found that a power function can be used to describe forgetting (Wickelgren, 1970, Wickelgren, 1972).

CHAPTER 3. METHODOLOGY

3.1 Theoretical Background for Demand System

Demand theory in the development of a demand system approach has been discussed in the works of Theil (1975), Barten (1966, 1968) and Deaton and Muellbauer (1980). The theory of consumer demand applied to systems of demand equations has been discussed extensively by Johnson et al. (1984), along with the assumptions and the restrictions resulting in the systems demand equations. The demand theory behind the systems of equations has been described through the use of a utility maximization approach. The utility maximization function allows for the incorporation of assumption regarding consumer behavior through utility functions. The utility function is denoted as:

$$u = u(q)$$

where q = (q_i) is the vector of quantity demanded for i_{th} commodity per unit of time. The utility function is assumed to be strictly increasing, strictly quasi-concave and twice continuously differentiable. The assumption of strict increasingness denotes that the consumer always prefers more to less. The assumption of strict quasi concavity ensures that a utility function does not contain linear segments or bends backward. While the twice continuously differentiable assumption ensures that indifference curves are well defined and are not kinked (Johnson, et al., 1984).

The first derivatives of the utility function are also known as marginal utilities. The marginal utilities are those increases in total utility that come with the consumption of an additional amount of commodity.

$$u_i = \frac{\partial u}{\partial q_i} > 0$$

The marginal utilities are positive. The assumption of continuity and differentiability allows for the second derivative of the utility function.

$$u_{ij} = \frac{\partial^2 u}{\partial q_i \partial q_j} = \frac{\partial^2 u}{\partial q_j \partial q_i} = u_{ji}$$

The second derivative of the utility function indicates the rate of change of marginal utility. It is assumed to be symmetric and negative definite.

The utility function is maximized subject to the budget constraint $p'q = m$ where, p = (p_i) vector of prices and m is the income. Maximization of the utility function subject to budget constrained is performed using the Lagrangian method.

$$u_i = \lambda p_i$$

or $L(q, \lambda) = u(q) - \lambda(p'q - m)$

where, λ is the Lagrangian multiplier. The Lagrangian multiplier can be interpreted as the marginal utility of income or the total expenditure. The first order conditions obtained after differentiating the Lagrangian multiplier with respect to q_i and λ are,

$u_q - \lambda p = 0$, and $p'q - m = 0$

The first order conditions can be solved for q_i's and λ in terms prices and income or expenditure using implicit function theorem as

$$q_i = q_i(p_1, \dots, p_n, m)$$

$$\lambda = \lambda(p_1, \dots, p_n, m)$$

The first equation explains a consumer's response when presented with alternative set of prices and particular value of income/expenditure. In the second equation, λ indicates the marginal utility of income (or expenditure), which is dependent on prices and income/expenditure level.

The restrictions on consumer demand functions are obtained by taking partial derivatives of the first order conditions for both price and income/expenditure.

Holding prices constant and differentiating for the first order condition with respect to m yields:

$$\sum_j \frac{\partial^2 u}{\partial q_i \partial q_j}\frac{\partial q_j}{\partial m} = p_i \frac{\partial \lambda}{\partial m}$$

$$\sum_j p_j \frac{\partial q_j}{\partial m} = 1$$

This can also be written in matrix notations as:

$UQ_m = \lambda_m p$ and $p'Q_m = 1$

where U is the hessian of the utility function, $Q'_m = (\partial q_1/\partial m, \ldots, \partial q_n/\partial m)$ and $\lambda_m = \partial\lambda/\partial m$

The first order conditions can be differentiated with respect to commodity k and price p_k holding other prices and m constant to obtain

$UQ_p = p\lambda'_p + \lambda I$ and $p'^{Q_p} = -q'$

where Q_p is a nxn matrix and λ'_p is the row vector of the marginal utility of income. Combining these two matrix notations, Barten (1969) presented a fundamental matrix equation for consumer demand theory,

$$\begin{bmatrix} U & P \\ p' & 0 \end{bmatrix}\begin{bmatrix} Q_m & Q_p \\ -\lambda_m & -\lambda'_p \end{bmatrix} = \begin{bmatrix} 0 & \lambda I \\ 1 & -q' \end{bmatrix}$$

The first matrix on the left side of equation is inverted to obtain solutions for the derivatives of demand equation with respect to p_i and m. The solutions from these demand equations are used to derive the restrictions on the demand parameters of the theory. The restrictions imposed on the demand equations are the Engel aggregation: $\sum_i p_i(\partial q_i/\partial m) = 1$; the Cournot aggregation: $\sum_i p_i\left(\partial q_i/\partial p_j\right) = -q_j$, the symmetry restriction: $\partial q_i/\partial p_j +$

$(\partial q_i/\partial m)q_j = \partial q_j/\partial p_i + (\partial q_j/\partial m)q_i$; and the homogeneity restriction: $\sum_j p_j(\partial q_i/\partial p_j) + m(\partial q_i/\partial m) = 0$

Altering these restrictions and imposing them in a utility maximization framework yields demand system specifications.

3.1.1 <u>Demand Systems Framework</u>

Demand system specifications introduced in the literature relate to the utility maximization framework with certain restrictions imposed. In these demand system specifications joint estimation of parameters is more feasible by reducing the number of coefficients in the complete system of demand functions(Johnson, et al., 1984). Theil (1980) presents two different approaches to deriving a system of demand—an algebraic form of utility function and the demand equations in terms of differentials (Theil, 1980). Several studies (Brown, et al., 1995, Matsuda, 2005, Yuan, et al., 2009) used and compared the different differential demand systems against the synthetic model proposed by Barten in his 1969 study. Barten's Synthetic model artificial nests four conventional demand systems Rotterdam, CBS, AIDS and NBR using scalar weights. Following Theil's discussion, another guide to deriving a system of demand is Matsuda's 2005 study, which discussed a general class of differential demand systems (Matsuda, 2005). Consider the Marshallian demand function for good i, $q_i(p,M)$ where p is the price vector, q is the quantity vector, and M is total expenditure. Assume that the consumer's utility function u(q) has a positive first-order derivative and continuous second-order derivative (Theil, 1980). Totally differentiate $q_i(p,M)$:

$$(1) \qquad \partial q_i(p,m) = \frac{\partial q_i(p,m)}{\partial m} dm + \sum_j \frac{\partial q_i(p,m)}{\partial p_j} dp_j\,, \quad i = 1, \dots, n,$$

For the $h_i(p,u)$ Hicksian demand function of good i, and reference utility u, the Slutsky equation expressing relation between the Marshallian and Hicksian demand functions is given as:

$$(2) \qquad \frac{\partial q_i(p,m)}{\partial p_j} = \frac{\partial h_i(p,u)}{\partial p_j} - \frac{\partial q_i(p,m)}{\partial m} q_j(p,m), \qquad i,j = 1,\dots,n.$$

The adding-up condition is totally differentiated are defined as follows:

$$(3) \qquad \sum_i p_i dq_i = dm - \sum_i q_i dp_i$$

Substituting equation (2) in equation (1), and using equation (3) and multiplying both sides of equation by p_i/m to obtain:

$$(4) \qquad w_i dlnq_i = p_i \frac{\partial q_i(p,m)}{\partial m} dlnQ + \sum_{j=1}^{n} \frac{p_i p_j}{m} \frac{\partial h_i(p,u)}{\partial p_j} dlnp_j$$

Where ln is the natural logarithm, $w_i = p_i q_i / m$ denotes the expenditure share of the i^{th} good, $dlnQ = \sum_i w_i dlnq_i$ denotes the Divisia volume index, $p_i \partial q_i / \partial m$ is marginal budget share of i^{th} good, and $\frac{p_i p_j}{m} \frac{\partial h_i(p,u)}{\partial p_j}$ is the ij^{th} element of the Slutsky matrix which involves the substitution effect of price changes. Equation (4) is the general equation for the differential demand system. The different approximations to the marginal budget share and Slutsky terms yield different types of differential demand systems.

If both marginal budget share and Slutsky terms are approximated to be constant, it would yield a Rotterdam model, which is one of the most used differential demand systems:

$$(5) \qquad w_i dlnq_i = b_i dlnQ + \sum_{j=1}^{n} s_{ij} dlnp_j$$

Now by subtracting $w_i dlnQ$ from both sides of equation (5) and by defining a new parameterization$c_i \equiv b_i - w_i$, an alternative specification of a differential demand system known as CBS model is derived as:

(6) $$w_i(dlnq_i - dlnQ) = c_i dlnQ + \sum_{j=1}^{n} s_{ij} dlnp_j$$

Let $dlnP = \sum_i w_i dlnp_i = dln\, m - dln\, Q$ denote the Divisia price index and δ_{ij} denote the Kronecker delta, $\delta_{ij} = 1$ if $i = j$ and zero otherwise. Next adding $w_i(dln\, p_i - dln\, P)$ to both sides of equation 6, the relation obtained:

(7) $$w_i(dln\, p_i + dln\, q_i - dln\, m) = dw_i$$

And then adding parameter $r_{ij} \equiv s_{ij} + w_i(\delta_{ij} - w_j)$ gives us:

(8) $$dw_i = c_i dlnQ + \sum_{j=1}^{n} r_{ij} dlnp_j$$

Equation (8) is the linear approximation of the AIDS model in the differential form. Another alternative parameterization of a differential demand system is obtained by adding $w_i dln\, Q$ to both sides of equation (8) to obtain the NBR model:

(9) $$dw_i + w_i dln\, Q = b_i dlnQ + \sum_{j=1}^{n} r_{ij} dlnp_j$$

Notice that the right-hand sides of equations 5, 6, 8 and 9 are alike and the left-hand sides differ, and if the relation derived from equation (7) is injected, you obtain:

$$dw_i = w_i dln\, q_i - w_i dlnQ + \sum_{j=1}^{n} w_i(\delta_{ij} - w_j) dlnp_j$$

The dependent variables of the CBS, AIDS and NBR models are rearranged to match the dependent variable in the Rotterdam model, so the equations can be written as:

(10) $$w_i dlnq_i = (c_i + w_i) dlnQ + \sum_{j=1}^{n} s_{ij} dlnp_j$$

$$(11) \qquad dw_i dln\, q_i = (c_i + w_i) dlnQ + \sum_{j=1}^{n} [r_{ij} - w_i(\delta_{ij} - w_j)] dlnp_j$$

$$(12) \qquad w_i dln\, q_i \ = b_i dlnQ + \sum_{j=1}^{n} [r_{ij} - w_i(\delta_{ij} - w_j) dlnp_j$$

With a change in expenditure shares, the marginal budget shares for the Rotterdam and NBR models remain constant and vary for the AIDS and CBS models, while the Slutsky term remains constant for the Rotterdam and CBS models and vary for the AIDS and NBR models.

3.1.2 <u>Barten's Synthetic Model</u>

Equations 5, 6, 8 and 9 can be written as single general equation known as the Barten's Synthetic Model (BSM). While most studies have followed a static demand system model, this study will incorporate a dynamic demand system to estimate the changes during the pre-event and the post-event period of a product. Barten's Synthetic Model nests all four of the above mentioned forms (5, 6, 8, and 9). Barten's Synthetic Model is given as:

$$w_i d\ logq_i = (\beta_i + \ \lambda w_i) dlogQ + \sum_j \left(\gamma_{ij} - \mu w_i(\delta_{ij} - w_j)\right) dlogp_j + \ \varepsilon_i\, , i = 1, \dots, n, \qquad (13)$$

where w_i is the budget share of i^{th} brand; q_i is the quantity of the i^{th} product, δ_{ij} is Kronecker delta equal to unity if i=j, zero otherwise, p_j is the price of brand j, while λ, μ, β, γ_{ij} are the parameters to be estimated, dlogQ is the Divisia Volume Index, which can be written as:

$$dlogQ \ = \ \sum_i w_i dlogq_i$$

Equation (13) becomes a Rotterdam model when both λ and μ are restricted to be zero, the CBS model when λ=1 and μ=0, the AIDS model when λ =1 and μ=1, and the NBR model when λ =0 and μ=1.

The demand restrictions for equation (13) are:

Adding up:

$$\sum_{i=1}^{n} \beta_i = 1 - \lambda_i \text{ and } \sum_{i=1}^{n} \gamma_{ij} = 0,\ j = 1, \dots, n,$$

Homogeneity:

$$\sum_{i=1}^{n} \gamma_{ij} = 0, \qquad j = 1, \dots, n,$$

Symmetry:

$$\gamma_{ij} = \gamma_{ji}, \qquad i, j = 1, \dots, n, i \neq j$$

The corresponding compensated price elasticities for equation (13) are

$$\epsilon_{ij}^{c} = \frac{\gamma_{ij}}{w_i} - \mu\left(\delta_{ij} - w_j\right)$$

where w_i and w_j denote the budget shares for commodities i and j and δ is the Kronecker delta. The uncompensated price elasticities that are calculated using Slutsky's equation are given as:

$$\epsilon_{ij}^{u} = \epsilon_{ij}^{c} - \epsilon_i w_j$$

The uncompensated cross-price elasticities are calculated as:

$$\epsilon_{ij}^{u} = \left(\frac{w_j}{w_i}\right) \epsilon_{ji}^{u} + w_j(\epsilon_j - \epsilon_i)$$

where ϵ_i and ϵ_j are the expenditure elasticities for product i and j, respectively, given as:

$$\epsilon_i = \frac{\beta_i}{w_i} + \lambda$$

3.2 Polynomial Inverse Lag

Mitchell and Speaker (1986) proposed the Polynomial Inverse Lag (PIL) technique, later used by Beach et al (2008), to identify the duration consumers remember news. The technique has a flexible shape and can be easily employed in nested least squares regression models. It is similar to Almon lag structure technique but has infinite lags and thus does not require the fixing of the lag length (Mitchell and Speaker, 1986).

Consider the following regression model:

$$Y_t = b + \sum_{i=0}^{\infty} w_i X_{t-i} + e_t$$

where Y_t is the commodity consumed in period t, X_t is the weekly article count of different media outlets, b is the collection of other explanatory variables, e is residual, and w_i's are the distributed lag weights. Assuming w_i's can be described as:

$$w_i = \sum_{j=2}^{n} \frac{a_j}{(i+1)^j} \quad , i = 0, \ldots\ldots, \infty$$

where a_j's are the parameters to be estimated, after substituting (2) in (1) and rearranging,

$$Y_t = b + \sum_{j=2}^{n} a_j Z_{jt} + R_t + e_t$$

where

$$Z_{jt} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^j} \quad , \qquad j = 2, \ldots \ldots n$$

$$R_t = \sum_{j=2}^{n} \sum_{i=1}^{\infty} \frac{a_j X_{t-i}}{(i+1)^j}$$

where R_t is the remainder term, data are not available for the calculation of R_t and this term is negligible if t is greater than eight (Mitchell and Speaker, 1986). Thus this study estimates the model without the first eight data points and Rt can be excluded from the analysis.

The $Z_{jt,}$ after dropping the first eight data points from the dataset, are obtained as:

For j=2

$$Z_{2t} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^2} = \frac{X_t}{1^2} + \frac{X_{t-1}}{2^2} + \frac{X_{t-2}}{3^2} + \frac{X_{t-3}}{4^2} + \cdots + \frac{X_1}{t^2};$$

For j=3:

$$Z_{3t} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^3} \quad = \frac{X_t}{1^3} + \frac{X_{t-1}}{2^3} + \frac{X_{t-2}}{3^3} + \frac{X_{t-3}}{4^3} + \cdots + \frac{X_1}{t^3};$$

For j=4;

$$Z_{4t} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^4} \quad = \frac{X_t}{1^4} + \frac{X_{t-1}}{2^4} + \frac{X_{t-2}}{3^4} + \frac{X_{t-3}}{4^4} + \cdots + \frac{X_1}{t^4};$$

For j=5

$$Z_{5t} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^5} \quad = \frac{X_t}{1^5} + \frac{X_{t-1}}{2^5} + \frac{X_{t-2}}{3^5} + \frac{X_{t-3}}{4^5} + \cdots + \frac{X_1}{t^5};$$

And so on for j=n

$$Z_{nt} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^n} \quad = \frac{X_t}{1^n} + \frac{X_{t-1}}{2^n} + \frac{X_{t-2}}{3^n} + \frac{X_{t-3}}{4^n} + \cdots + \frac{X_1}{t^n};$$

The appropriate degree of polynomial, n, is chosen by successively regressing the equation (3) starting from a high degree then dropping the highest degree terms. Appropriate degree is defined by minimizing the estimated variance. As proposed by Beach et al. (2008), this study also uses the square root of number of media stories while generating polynomial terms to account for the diminishing returns on the additional information. This study uses Akaike Information Criterion and R-square along with other majors to fit the data.

The weights are recovered using the estimates a_j on the number of newspaper articles.

$$w_i = \sum_{j=2}^{n} \frac{a_j}{(i+1)^j} \quad , i = 0, \ldots\ldots, t-1$$

3.3 Information and Consumer Demand

The effect of information has been well documented in past studies. Mizerski (1982) first introduced attribution theory by modeling information processing, explaining the disproportionate weighing of unfavorable product information. Attribution theory refers to the perspective on information processing where "individuals differ in processing of favorable and unfavorable information because of the perceived cause to which information is attributed" (Mizerski, 1982). Later studies explained the psychological concept of attribution theory from an economic perspective. Swartz and Strand (1981) stated that the consumer's level of utility is affected by their perception of quality. They incorporated the consumer's acquired information to analyze the effect on the consumers' perception of quality and consumers' utility. The consumers utility function is expressed as $U[q_i(Z_i(N))]$, where q is the amount of the primary good, Z is the quality variable associated with the primary good and N is the information associated with the primary good. Following Swartz and Strand (1981), Smith et al. (1988) used a similar approach to estimate the loss of milk sales after information regarding heptachlor contamination reached consumers. They used a similar utility maximization theory, with a different approach to incorporate the media information in the model (Smith, et al., 1988).

Swartz and Strand (1981) accounted for the effect of aggregated media coverage on demand, whereas Smith et al. (1988) distinguished between publicized positive and negative information. The authors used a dynamic regression model to estimate the results of the study. The study found that media coverage following the milk contamination incident had a significant effect on milk purchases, and also found that negative media coverage had outweighed positive media coverage. Chang and Kinnucan (1991) also extended the attribution theory to estimate the effect of information on the demand for butter. Unlike Smith et al. (1988), Chang and Kinnucan

(1991) separated positive and negative information. The study found that consumers' responses to negative information outweighed their responses to positive information, but they also found that industry advertising had a positive effect (Chang and Kinnucan, 1991).

Using a variation of Chang and Kinnucan's extension of Swartz and Strand's utility based approach of valuing information, Richards and Patterson (1999) modified the utility function to accommodate the variation in demand due to positive and negative information. Suppose in a situation where utility is derived from consumption of the attributes (Z) of a commodity and is a function of information (N). In a state of equilibrium with no new information coming in perception about the commodity would not change and thus the utility would stay at a steady state. Let's call the state of information N^*. Now suppose if new information arrives, that would, in turn, change the reference level of consumer's perception. Suppose the new information state is $\widehat{N}$. Negative information would lower ($\widehat{N} - N^* < 0$) the consumers perception compared to the reference level, whereas positive information would cause perception to rise($\widehat{N} - N^* > 0$).The utility function presented by Richards and Patterson (1999) is,

$$U(q_i) = \begin{bmatrix} U\left(q_i^+\left(Z_i(\widehat{N} - N^*)\right)\right) = U\left(q_i^+\left(Z_i(\widetilde{N})\right)\right) if\ \widetilde{N} > N^* \\ U\left(q_i^-\left(Z_i(\widehat{N} - N^*)\right)\right) = U\left(q_i^-\left(Z_i(\widetilde{N})\right)\right) if\ \widetilde{N} < N^* \end{bmatrix}$$

where q_i is the quantity of product i, Z_i is the vector of attributes for product I, $\widehat{N}$ is the consumers current state of perception about the safety of food product, and N^* is the reference state of food safety perception.

Richards and Patterson (1999) reason that given a well behaved increasing concave utility function, not only will the negative information lower the perception of consumer regarding safety of a food product, but will also dominate the rise in utility due to positive information

(Richards and Patterson, 1999). This can be represented as $\left|dU^{+}/d\widetilde{N}\right| < \left|dU^{-}/d\widetilde{N}\right|$. Captivating the idea from information theory, this study makes an effort at identifying the differences between effect positive and negative information on the consumer behavior.

3.4 Information and Sentiment Analysis

The previous studies have incorporated different methods to measure the amount of media coverage for a related food safety incident. Tansel (1993) used dummy variables to measure the effect of anti-smoking campaigns on cigarette demand in Turkey. The authors used an Ordinary Least Squares model (OLS) to estimate the information effect. The study found that the health warnings reduced cigarette consumption by 8%. The study also found the effects of health warnings to be stronger than the effect of advertising (Tansel, 1993). A study by Smith et al. (1988) used actual newspaper article counts, marked as positive or negative, to analyze the impact of media coverage on a specific event (Smith, et al., 1988). Chang and Kinnucan (1991) used a cumulative number to create a media index to analyze the impact of cholesterol information on the consumption trends of fats and oils (Chang and Kinnucan, 1991).

This study uses the media stories from several different media sources in the analysis. Identifying positive and negative articles is difficult. In the past literature defining the tone of a published article or its intensity has been subjective to individual readers. To overcome these issues, this study uses a sentiment analysis that identified certain keywords or combination of keywords and phrases in a given text or article and designate it as positive, negative or neutral emotion. Based on the scores for each word in the text, a combined score is assigned for the whole text ranging from -2 to +2. These assigned scores are then used to create an index. Sentiment analysis can use natural language processing, text analysis, computational linguistics or other techniques to identify and evaluate the material. This study uses natural language processing algorithm provided by Semantria to process the news stories. Natural language processing helps parse the text into it's basic parts, such as subject, verb, adjective, and other parts-of-speech. By giving relevant words positive or negative scores, which can then be aggregated to calculate the overall tone of a body of text. Semantria's sentiment analysis is trained to identify positive, negative, and neutral words. Humans can only agree on whether or not a sentence has the correct sentiment, 80% of the time, Semantria's algorithm gives 70-75% accuracy for the sentiment analysis of the texts. Additionally, algorithm provides a score to depict the intensity of a body of text (semantria.com).

The positive and negative sentiment scores over each week were aggregated to create separate positive and negative sentiment indices. A weekly net sentiment index was created by taking the difference between the positive and negative sentiment indices over the respective weeks. The scores on net sentiment index and negative sentiment index were reversed in order to parallel other variables interpretation. The number of story count per week was used as another metric and was called as information index.

The media stories were collected from different major media sources (*national newspapers, network and cable TV, radio, news magazines,* and *the internet)* using the academic version of Lexis-Nexis tool. The article or transcript counts the news stories containing at least one of the following key words: *food safety, food poisoning, food contamination, food borne illnesses, food-borne diseases,* and *food recall*. The identified articles were processed through a sentiment analysis algorithm to obtain the sentiment score for the news article.

3.5 Data

This study uses Nielsen HomeScan panel data for the years 2008, 2009 and 2010. The Nielsen HomeScan data record the weekly grocery purchases of 60,000 U.S. households, and is considered the largest grouping of continuous panel data. Panel respondents are equipped with handheld barcode scanners which they use to register their purchases. The products required in this study were identified using a unique product module number assigned for each product.

For the PCA peanut butter recall, the households with at least one purchase of Peanut butter, Jelly, Marmalade, Preserves and Jams were included in the sample. For the refrigerated cookie dough recall, households with at least one purchase of cookie dough during the study period were included in the sample. The refrigerated cookie dough market is well defined, with four to five major brands, which for confidentiality purposes will remain anonymous. The data separates the cookie dough produced by the two major brands, Brand1 and Brand2, the Store Brand and Other Brands. For the Gulf oil spill incident, the meat products considered were frozen seafood, poultry, beef, pork, fresh meats and other frozen meat products. The households with at least one purchase of any meat product during the study period were included in the sample.

The quantity and expenditure was expressed in terms of ounces purchased and cents spent per household per week. The quantity purchased was constructed by aggregating the total ounces of each product purchased by households on a given week and dividing by the number of households for the week. Similarly, expenditures on products were calculated by aggregating weekly expenditures for each product and dividing by the number of households for the week. Expenditures were then converted from dollars to cents. Per unit prices for every product used in the study were calculated by dividing total expenditure by total ounces of quantity purchased per week. The prices were then deflated using the Bureau of Labor Statistics' (BLS) Consumer Price Index (CPI) for base period 1982-1984. Since the CPI was reported on a monthly basis, this study had to use PROC EXPAND in SAS 9.3 to interpolate a weekly series for the Consumer Price Index (CPI).

In the case of the PCA peanut butter recall, the equation of product category jam was omitted to avoid the singularity of the covariance matrix and the Iterative Seemingly Unrelated Regression (ITSUR) procedure to obtain the estimates by imposing parametric restrictions. The differential form of the data series used in the analysis was tested for unit root. Augmented Dickey-Fuller and Phillips-Perron tests found the differential form of the variables to be stationary.

The cookie dough produced by Brand1 was taken off the shelves for a period of eight weeks, from June 19, 2009 to August 18, 2009. The study separates data in pre-event and post-event periods. The pre-event period sample was from the week of January 1st, 2008 to the week of June 19th, 2009 and post-event period sample from the week of August 18th, 2009 to the week of December 31st, 2010. This study used the Iterative Seemingly Unrelated Regression (ITSUR) procedure to obtain the estimates by imposing parametric restrictions. The equation of Other brands was omitted to avoid the singularity of the covariance matrix. The differential form of the data series used in the analysis was tested for unit root. Augmented Dickey-Fuller and Phillips-Perron tests found the differential form of the variables to be stationary.

For the Gulf oil spill case the equation of Frozen Other meat was omitted to avoid the singularity of the covariance matrix. The differential form of the data series used in the analysis was tested for unit root. Augmented Dickey-Fuller and Phillips-Perron tests found the differential form of the variables to be stationary.

CHAPTER 4. RESULTS AND DISCUSSION

This section presents results from the three cases described earlier. Demand systems have been a popular tool in studying the effect of information on the demand. For example, Piggott and Marsh (2004) used an AIDS model approach to estimate the impact of food safety information on U.S. meat demand. Verbeke and Ward (2001) and Burton and Young (1996) fitted a media index in the AIDS model to capture the effect on demand. Marsh et al. (2004) used a Rotterdam demand model to analyze the impact of a meat recall on demand. Kinnucan et al. (1997) also used a Rotterdam model to identify the effect of health information and generic advertising on U.S. meat demand.

However, several studies have also used single equation models. For example, in a very early study, Brown (1969) used a very simple straightforward linear and logarithmic least squares model to estimate the effect of a health hazard scare related to cranberries on consumer demand. Dahlgran and Fairchild (2002) used a nonlinear regression model, while Beach et al. (2008) used a linear model with Polynomial Inverse lags to find the effect on demand.

Following the precedent established in the previous literature, this study first presents the results from a demand system approach which identifies the effect of food recall information on demand. The system of equations exploits the inter-correlation extant between groups of commodities so as to provide the demand relationship between said commodities. The use of almon lags of the media indices in the demand system model allows testing for the effect of information. This study incorporates a net sentiment index, an information index and positive and negative sentiment indices separately for each case. This study then investigates further the effect of information on demand using a single equation approach with Polynomial Inverse Lag

(PIL) structure incorporated. The weights obtained from the PIL terms were used to identify weekly fluctuations in demand.

4.1 PCA Peanut Butter Recall

4.1.1 Demand System Model

The data used in this study were for the years 2008, 2009, and 2010. Table 2 includes the descriptive statistics results for the mean quantities purchased per household per week and the mean price paid in cents per ounce per household per week.

Table 2:Descriptive Statistics for Spreads Quantity and Prices

		Quantity (Ounces)		Price (cents/Ounce)	
Product	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Peanut Butter	156	34.32	1.28	4.89	0.31
Jelly	156	30.05	1.63	3.25	0.30
Marmalade	156	18.85	1.01	6.72	0.35
Preserves	156	23.08	0.64	6.16	0.25
Jams	156	28.00	2.04	4.78	0.43

The average quantity purchased per week was highest for peanut butter with 34.32 ounces. The lowest average quantity purchased per week was for marmalade with 18.85 ounces. However, marmalade had the highest average price paid per week of 6.72 cents/ounce, the lowest average price paid per week of 3.25 cents/ounce was for jelly.

Table 3 presents the results for the joint hypothesis tests of λ and μ. The results for the joint hypothesis tests support the use of Barten's Synthetic Model, which nests four differential demand systems viz. Rotterdam, CBS, AIDS and NBR into itself. The synthetic model has two more parameters than specific functional forms, which makes it slightly more flexible. The synthetic model becomes a Rotterdam model when both λ and μ are restricted to be zero, the CBS model when $\lambda=1$ and $\mu=0$, the AIDS model when $\lambda=1$ and $\mu=1$, and the NBR model when

λ =0 and μ=1. With a change in expenditure shares, the marginal budget shares for the Rotterdam and NBR models remain constant and vary for the AIDS and CBS models. However, the Slutsky term remains constant for the Rotterdam and CBS models and varies for the AIDS and NBR models.

Table 3: Test of Nested Models for Spreads

Model	Test	χ^2 Statistics	P-value
Rotterdam	H0: λ=0, μ=0	10.24	0.0060
CBS	H0: λ=1, μ=0	5.67	0.0587
AIDS	H0: λ=1, μ=1	6.25	0.0439
NBR	H0: λ=0, μ=1	10.72	0.0047

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at α = 0.05

The model was corrected for autocorrelation using the AR1 model. The Durbin-Watson statistics for the model are presented in the appendix of this study along with the estimated coefficients for the variables included in the model.

The results of the compensated own-price and cross-price elasticities for the peanut butter and related products during the study period are presented in Table 4. All the elasticities were calculated at the sample means of budget shares for time period of the study.

The compensated own-price elasticity indicates a percent change in the quantity demanded of the product with the percent change in the price. All the compensated own-price elasticities were significant and negative, satisfying the law of demand.

Table 4: Compensated Own-Price and Cross-Price Elasticity for Spreads

Product	Peanut Butter	Jelly	Marmalade	Preserves	Jams
Peanut Butter	-0.4223***	0.1232***	0.0620**	0.0774**	0.1597***
Jelly	0.2123***	-0.5401***	0.1016***	0.1022**	0.1239***
Marmalade	0.0820**	0.0780***	-0.3820***	0.1006**	0.1213***
Preserves	0.0911**	0.0699**	0.0896**	-0.3339***	0.0833**
Jams	0.1978***	0.0915***	0.1139***	0.0908**	-0.4959***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level

The own-price elasticity for jelly was highest in magnitude (-0.54), indicating that it was the most elastic of all the product categories. The own-price elasticity for preserves was the most inelastic among the nested products (-0.33). For the three year data sample used in this study, this study found that all the cross-price elasticities to be significant and positive. Usually, peanut butter and jelly are considered to be complements but the positive sign on the cross price elasticity indicates that the products are substitutes. However, numbers of purchases for peanut butter were six times higher for this three year study period than for the number of purchases for jelly. Peanut butter is not only used in peanut butter jelly sandwiches but it also is used as an ingredient for other items such as cookies, pastries and cakes.

Expenditure elasticity measures the responsiveness of expenditure on, or consumption of a product to the change in real income, *ceteris paribus* where expenditure is a proxy for income. Thus expenditure elasticity measures the percentage change on a product as total expenditure increases (Tomek and Robinson, 2003). The estimates of uncompensated own-price, expenditure and sentiment elasticities are presented in the Table 5.

Table 5: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads

Product	Uncompensated Elasticity	Expenditure Elasticity	Net Sentiment Elasticity
Peanut Butter	-0.6545***	0.9242***	-0.0057
Jelly	-0.6635***	0.8462***	-0.0934
Marmalade	-0.6830***	1.5847***	-0.0494
Preserves	-0.4835***	0.7013***	0.0153
Jams	-0.6858***	0.9609***	0.1047

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level

The uncompensated elasticity was lowest for preserves similar to compensated own-price elasticity. However, uncompensated elasticity was highest for marmalade indicating that income (in this case, expenditure) effect was larger for marmalade. A further look at the expenditure elasticity of marmalade confirms our rationale. Marmalade has the most responsive expenditure elasticity among all the tested products.

In this study a dummy variable was created and carried a value of one after the announcement of PCA peanut butter recall and zero before the announcement. To test the effect of information sentiment an interaction variable between net sentiment index and the dummy variable was introduced in the system of equations. The model was tested using different lag lengths of the sentiment index. However, the study was unable to find a significant effect of information sentiment on the demand.

Table 6 compares elasticities of three media indices (net sentiment, information and positive and negative sentiment indices) mentioned earlier. The net sentiment elasticity was calculated using up to the first lag of net sentiment index. The information elasticity was calculated using up to the first lag of the information index. The negative sentiment elasticity was calculated using no lags of the negative sentiment index, while positive sentiment elasticity was calculated using up to the first lag of the positive sentiment index. This study was unable find a significant effect for the net sentiment and information index. However this study found that the negative sentiment index had a positive effect on jelly consumption.

Table 6: Net Sentiment, Information and Positive and Negative Sentiment Elasticities of Spreads for the Synthetic Model

	Net Sentiment Elasticity	Information Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.006	0.003	0.056	-0.338
Jelly	-0.093	0.007	0.215*	0.309
Marmalade	-0.049	0.007	-0.215	0.260
Preserve	0.015	-0.007	-0.037	0.125
Jam	0.105	-0.008	0.017	-0.186

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget shares. The elasticity estimates of media indices are computed using an interaction term with dummy variable denoting period after recall.

The positive statistical significance of negative sentiment elasticity for jelly indicates that the demand for jelly rose in response to negative media coverage of the recall. The result is supported by compensated cross-price elasticity between peanut butter and jelly indicating a significant net-substitutability.

This study calculates structural change in demand for the peanut butter and related products by way of estimating demand elasticities prior and after the PCA peanut butter recall event. The descriptive statistics for the mean quantities purchased per household per week and the mean price paid in cents per ounce per household per week for pre-event and post-event period are given in Table 7.

Table 7 :Descriptive Statistics for Spreads Quantity and Prices in Pre-event and Post-event Periods

		Quantity (Ounces)		Price (cents/Ounce)	
Pre-Event	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Peanut Butter	54	33.79	1.02	4.86	0.38
Jelly	54	30.37	1.59	3.09	0.28
Marmalade	54	18.74	0.99	6.70	0.36
Preserves	54	23.22	0.63	6.00	0.29
Jams	54	26.42	1.50	4.90	0.43
Post-Event	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Peanut Butter	104	34.58	1.31	4.91	0.26
Jelly	104	29.90	1.63	3.33	0.27
Marmalade	104	18.93	1.02	6.73	0.34
Preserves	104	23.02	0.65	6.24	0.18
Jams	104	28.85	1.76	4.71	0.41

In the pre-event period, the average quantity purchased per week was highest for peanut butter at 33.79 ounces. The lowest average quantity purchased per week was for marmalade at 18.74 ounces. However, marmalade had the highest average price paid per week at 6.70 cents/ounce, whereas the lowest average price paid per week of 3.09 cents/ounce was for jelly.

Similar to the pre-event period, in the post-event period average quantity purchased per week was highest for peanut butter at 34.58 ounces. The lowest average quantity purchased per week was for marmalade at 18.93 ounces. Again marmalade had the highest average price paid per week of 6.73 cents/ounce, the lowest average price paid per week was 3.33 cents/ounce for jelly.

Table 8 presents results of the likelihood ratio (LR) tests for the Barten's Synthetic (BSM) nested model. The results show that in the post-event period, the Rotterdam, CBS, AIDS and NBR model are rejected. The results are similar to those reported by Barten (1993), Brown, Lee and Seale (1994) and Matsuda (2005). In the post-event period, the likelihood ratio test was unable to reject all of the four models. It has to be mentioned that Barten's Synthetic model is not just an composite model of the known differential demand systems, but a demand system by itself (Matsuda, 2005). The failure of the likelihood ratio (LR) test to reject conventional models does not indicate the weakness of the synthetic model.

Table 8: Test of Nested Models for Spreads

		Pre-event		Post-event	
		χ^2 Statistics	P-value	χ^2 Statistics	P-value
Rotterdam	H0: λ=0, μ=0	15.43	0.0004	1.02	0.6019
CBS	H0: λ=1, μ=0	12.66	0.0018	0.30	0.8590
AIDS	H0: λ=1, μ=1	10.91	0.0043	0.34	0.8451
NBR	H0: λ=0, μ=1	13.65	0.0011	0.98	0.6132

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

This study presents and compares the results from the synthetic model and conventional differential demand systems. However, following the argument of Matsuda (2005) for the synthetic model to be less biased in its estimates, this study elaborates the results from synthetic model in detail for the post-event period and compares the elasticity estimates from the four conventional demand systems.

The own-price and cross-price elasticities for pre-event and post-event periods are presented in Table 9. The compensated own-price elasticities were statistically significant and satisfied the law of demand in both periods. The elasticity estimates for all the products were less than the unity in both the periods, indicating that the demand for the analyzed products to be inelastic. Compensated own-price elasticity was lowest for peanut butter in the pre-event period, however in the post-event period it was the highest. Magnitude of the own-price elasticity for peanut butter increased in the post-event period, suggesting that consumers became more responsive to the price changes for peanut butter.

Table 9: Own-Price and Cross-Price Elasticities of Spreads for the Synthetic model with Net Sentiment Index

		Peanut Butter	Jelly	Marmalade	Preserve	Jam
Pre-Event	Peanut Butter	-0.22***	0.02	0.04	-0.04	0.18***
	Jelly	0.04	-0.55***	0.12	0.27***	0.15*
	Marmalade	0.05	0.09	-0.38***	0.23***	-0.02
	Preserve	-0.04	0.18***	0.21***	-0.54***	0.23
	Jam	0.23***	0.11*	-0.02	0.25	-0.56***
Post-Event	Peanut Butter	-0.51***	0.13***	0.04	0.18***	0.26***
	Jelly	0.23***	-0.51***	0.12**	0.05	0.11**
	Marmalade	0.05	0.09**	-0.40***	0.07	0.21***
	Preserve	0.21***	0.03	0.06	-0.30***	0
	Jam	0.20***	0.08**	0.19***	0	-0.47***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget share

In the pre-event period peanut butter only had significant substitution effect with jam. However, in the post-event period peanut butter had significant substitution effect with jelly and preserve along with jam. The magnitude of net substitutability for peanut butter and jam also increased in the post-event period. The presence of net-substitution effect for peanut butter in the post-event period indicates a change in consumers purchase pattern.

Table 10 presents own-price and cross-price elasticities of Rotterdam, CBS, AIDS and NBR models along with synthetic model for the post-event period. The elasticity estimates in Table 10 demonstrate that elasticity estimates from synthetic model are very similar to the conventional models supporting Matsuda's (2005) argument.

Table 10: Estimated Compensated Own-Price and Cross-Price Elasticities of Spreads in Post-Event Period

Model	Product	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Synthetic	Peanut Butter	-0.5104***	0.1339***	0.0395	0.1822***	0.2585***
	Jelly	0.2287***	-0.5093***	0.1156**	0.0481	0.1055**
	Marmalade	0.0526	0.0902**	-0.4031***	0.0651	0.2055***
	Preserve	0.2149***	0.0332	0.0576	-0.3041***	-0.002
	Jam	0.1976***	0.0773**	0.1932***	-0.0021	-0.4660***
Rotterdam	Peanut Butter	-0.5094***	0.1365***	0.038	0.1826***	0.1524***
	Jelly	0.2330***	-0.5119***	0.1143**	0.0477	0.1169**
	Marmalade	0.0506	0.0891**	-0.4000***	0.0636	0.1968***
	Preserve	0.2152***	0.0329	0.0563	-0.2974***	-0.007
	Jam	0.1949***	0.0772**	0.1957***	-0.007	-0.4540***
CBS	Peanut Butter	-0.5098***	0.1343***	0.0397	0.1827***	0.1530***
	Jelly	0.2294***	-0.5095***	0.1163**	0.0478	0.1160**
	Marmalade	0.0529	0.0907**	-0.4057***	0.0638	0.1983***
	Preserve	0.2154***	0.033	0.0565	-0.3020***	-0.0029
	Jam	0.1915***	0.0850**	0.1865***	-0.0031	-0.4599***
AIDS	Peanut Butter	-0.5110***	0.1335***	0.0393	0.1817***	0.1566***
	Jelly	0.2279***	-0.5092***	0.1149**	0.0486	0.1179**
	Marmalade	0.0523	0.0896**	-0.4003***	0.0664	0.1921***
	Preserve	0.2142***	0.0335	0.0588	-0.3063***	-0.0002
	Jam	0.2004***	0.0776**	0.1905***	0.0017	-0.4628***
NBR	Peanut Butter	-0.5107***	0.1356***	0.0375	0.1817***	0.1559***
	Jelly	0.2315***	-0.5116***	0.1129**	0.0483	0.1189**
	Marmalade	0.0499	0.0880**	-0.3946***	0.0661	0.1906***
	Preserve	0.2142***	0.0334	0.0586	-0.3019***	-0.0043
	Jam	0.1997***	0.0787**	0.1896***	-0.0029	-0.4570***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

The uncompensated own-price, expenditure and sentiment elasticity for all four conventional models are presented in the appendix along with parameter estimates for the four conventional models.

The uncompensated own-price, expenditure and sentiment elasticity estimates for both periods are presented in Table 11. As per the expectations, all the uncompensated own-price elasticities from both the periods were significant and negative. The expenditure elasticity for all the products was significant and positive for both the periods. The increase in expenditure elasticity indicates an increase in quantity demanded for analyzed products as the expenditure on the products increase, *ceteris paribus* and vice-versa. Expenditure elasticity decreased for peanut butter and preserve in post-event period, while it increased for jelly, marmalade and jam.

Table 11: Uncompensated, Expenditure and Net Sentiment Elasticities of Spreads for the Synthetic Model

		Uncompensated Elasticity	Expenditure Elasticity	Net Sentiment Elasticity
Pre-Event	Peanut Butter	-0.45***	0.89***	-0.35
	Jelly	-0.63***	0.56***	-0.11
	Marmalade	-0.68***	1.52***	0.19
	Preserve	-0.79***	1.15***	0.16
	Jam	-0.72***	0.81***	0.17
Post-Event	Peanut Butter	-0.72***	0.85***	0.06
	Jelly	-0.65***	0.95***	0.22**
	Marmalade	-0.72***	1.67***	-0.12
	Preserve	-0.42***	0.56***	-0.11
	Jam	-0.67***	1.06***	0.00

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget share

To detect significant changes in the compensated own-price and cross-price elasticity across the two periods, this study conducted a chi-square test with the null hypothesis that elasticity estimates from the pre-event period are equal to those from the post-event period. The results for the chi-squared tests are presented in Table 12. Changes in the magnitude of the elasticity estimates are listed in the first column of Table 12 along with the products involved in the test. The chi-squared tests confirm that only compensated, own-price elasticity for peanut butter and preserves changed significantly from the pre-event to post-event periods. Peanut butter consumption became more price responsive, while preserves became less price responsive in the post-event period. This study was unable to find significant change in cross-price elasticities between these two periods.

Table 12: Test for differences in Pre-event and Post-event period Elasticities of Spreads

	$\chi 2$ statistics	p-value
Compensated Own-Price Elasticity		
Peanut Butter = -0.287	14.74	0.0001
Jelly = 0.04	0.25	0.6201
Marmalade= 0.021	0.03	0.8580
Preserves= 0.2404	4.61	0.0317
Jams= 0.106	0.04	0.8381
Cross-Price Elasticity		
Peanut Butter_Jam= 0.078	2.01	0.1559
Jelly_Jam= -0.045	0.34	0.5580
Jam_peanut Butter= -0.031	0.21	0.6496
Jam_Jelly= -0.031	0.32	0.5695
Uncompensated Elasticity		
Peanut Butter= -0.2746	9.67	0.0019
Jelly= -0.01	0.05	0.8281
Marmalade= -0.42	0.11	0.7427
Preserve= 0.366	7.81	0.0052
Jam= 0.04	1.58	0.2084
Expenditure Elasticity		
Peanut Butter= -0.046	0.11	0.7411
Jelly= 0.394	4.71	0.0299
Marmalade= 0.149	0.28	0.5952
Preserve= -0.585	13.80	0.0002
Jam= 0.257	12.45	0.0004

The null hypothesis for the test is that pre-event period elasticity estimates are equal to post-event period. The values next to the products tested are differences in estimate from pre-event to post-event period.

The chi-squared tests also showed that uncompensated own-price elasticity of peanut butter and preserves changed significantly from pre-event to post-event period. The expenditure elasticity changed significantly for jelly, preserves and jam from pre-event to post-event period. The expenditure elasticity increased for jelly and jam while it decreased for preserves in post-event period compared to pre-event period.

Table 13 presents net sentiment, information and positive and negative elasticity estimates for the pre-event and post-event periods. As discussed earlier, the net sentiment index did not have an effect on the consumption of products analyzed in the study. However, in the post-event period the increase in the net sentiment index had a positive effect on the consumption of Jelly. Information index did not have a significant effect in either the pre-event or the post-event periods on the products analyzed. In the pre-event period study found that positive sentiment index had a positive effect on the consumption of jelly and negative effect on the consumption of marmalade.

Table 13: Estimated Sentiment, Information and Positive and Negative Elasticities of Spreads in Pre-event and Post-Event period

		Sentiment Elasticity	Information Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Pre-Event	Peanut Butter	-0.352	0.004	-0.030	-0.127
	Jelly	-0.113	-0.007	-0.174	1.739**
	Marmalade	0.188	0.004	0.246	-1.688*
	Preserve	0.157	-0.004	-0.096	0.411
	Jam	0.174	0.000	0.014	0.101
Post-Event	Peanut Butter	0.056	0.000	0.056	-0.074
	Jelly	0.222*	0.008	0.232**	-0.235
	Marmalade	-0.119	-0.002	-0.120	0.132
	Preserve	-0.113	-0.007	-0.112	0.039
	Jam	0.000	0.003	0.000	0.094

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget share

In the post-event period similar to the net sentiment index, negative sentiment index also had a positive effect on the consumption of jelly, while positive sentiment index did not have a significant effect on any product. The results of media indices from the post-event period confirm that the negative information in the post-event period did help to increase the consumption of jelly, which had significant substitution effect with peanut butter.

4.1.2 Polynomial Inverse Lag Model

In the demand system approach, this study was unable to find the direct effect of information on the demand for the peanut butter after the announcement of the PCA peanut butter recall. However, a 2009 study by the Harvard Opinion Research Program found that one in four consumers believed that major peanut butter brands were involved in the recall. This study tested a single equation approach to identify the effect of information. This study uses a linear regression model utilizing polynomial inverse lag (PIL) structure which was introduced by Mitchell and Speaker in 1986 as an improvement over the almon lag structure in a single equation setting. Since PIL does not require number of lags to be set by the researcher, PIL has an infinite distributed lag structure (Mitchell and Speaker, 1986).

The data used were from the point when FDA announced the linkage between salmonella and the PCA peanut butter paste starting from January 9^{th}, 2009 to December 31^{st}, 2010. The dependent variable in the model was log of average weekly quantity of peanut butter consumed similar to the demand system model. The log price of peanut butter was included as an explanatory variable along with prices of other spreads like Jams, Jelly, Marmalade and Preserves.

The dependent variable was tested for the stationarity using Augmented Dickey-Fuller unit-root test, with the null hypothesis that variable is non-stationary. The results of Augmented

Dickey-Fuller unit-root test confirmed that the log quantity of peanut butter was stationary. The results for the Breusch–Godfrey test rejected the null hypothesis of no serial correlation and the results of Durbin-Watson test, after a general OLS model, showed that the model requires autoregressive correction. This study tested different models, before finalizing a Prais-Winsten and Cochrane-Orcutt log-log regression model. The Prais-Winsten and Cochrane-Orcutt regression use a generalized least squares estimator and accounts for the serial correlation in the model by integrating first order autoregressive process. After testing for different combinations, with the use of Akaike Information Criterion (AIC), the results from the estimated demand equation for peanut butter are presented in Table 14.

Table 14: Polynomial Inverse Lag Model for Peanut Butter with Information Index

Variable	Estimate	Std. Error	t-statistics	P-value
Constant	4.5855	0.1906	24.0600	0.0000
ppb[a]	-0.7566	0.1000	-7.5700	0.0000
pjelly[a]	-0.0005	0.0381	-0.0100	0.9890
pmarm[a]	-0.0370	0.0472	-0.7800	0.4350
ppres[a]	-0.0216	0.0978	-0.2200	0.8260
pjam[a]	0.1290	0.0599	2.1500	0.0340
z2[b]	-1.1791	0.2385	-4.9400	0.0000
z3[b]	7.9864	1.6594	4.8100	0.0000
z4[b]	-15.7038	3.3158	-4.7400	0.0000
z5[b]	8.8958	1.8945	4.7000	0.0000
ρ1	0.2781			
AIC	-447.7199			
R-square	0.5598			
Durbin-Watson	1.8			
N	93			

[a]ppb, pjelly, pmarm, ppres and pjams are the prices for peanut butter, jelly, marmalade, preserves and jams, respectively.
[b]z2, z3, z4, and z5 are the second, third, fourth and fifth degree polynomials of information index

The estimated price elasticity of demand for the peanut butter was -0.75 and was significant at one percent level of post-event period. The own price elasticity of peanut butter in demand system was -0.51. The estimates for jelly, marmalade and preserve were not significant. The price elasticity for jam was 0.13 in the PIL model, which indicates a substitution effect similar to earlier demand system model. All the PIL terms were significant at one percent level in the model.

The results show that media information about food recalls had a statistically significant effect on the demand for peanut butter after the 2009 peanut butter recall event. The polynomial transformation of the information lag structure allows us to estimate the declining marginal effects.

$$(4.1) \qquad w_i = \sum_{j=2}^{n} \frac{a_j}{(i+1)^j} \ , i = 0, \ldots\ldots, t-1$$

The estimates of the polynomial information index were used to construct weights w_i mentioned in equation (4.1). The calculated weights indicate a percentage change in consumption in the respective week. For example, a weight of -0.0034 is interpreted as a 0.34 percent decrease in consumption of peanut butter for the respective week.

The weekly weights, w_i's, were plotted against time in the Figure 3. The timeline for this study started in the second week of 2009 (on January 9th, 2009 the FDA launched an investigation in PCA's Georgia facility). During the next couple of weeks PCA expanded its product recall in a stepwise manner. Although the number of media stories reporting food safety incident started gradually increasing, it peaked in fifth week of study when Stewart Parnell, owner of PCA appeared before the House Energy and Commerce Subcommittee during a hearing on the outbreak. The plot in Figure 3 shows the percentage change in consumption of peanut butter in response to the information index. The shift in response peaked in fifth and sixth week after the incident. Although, it rapidly degenerated after the first few weeks, it still had a sizeable effect for next 30 weeks.

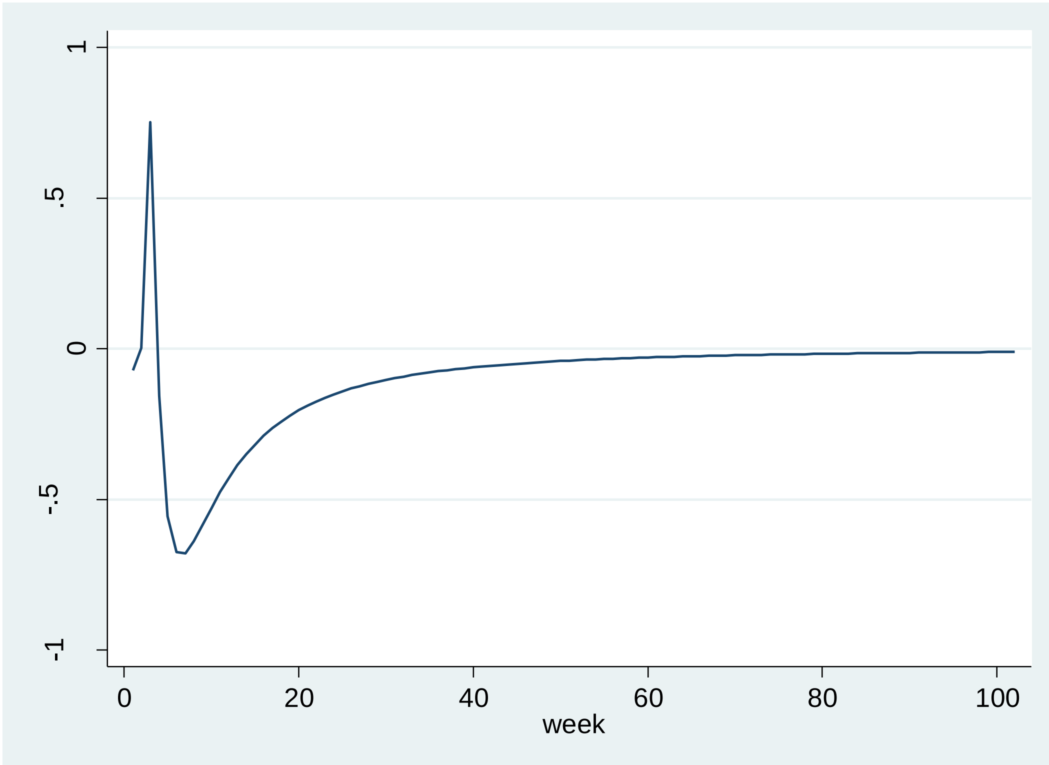

Figure 3: Weekly changes in Peanut Butter Purchases associated with Information Index

The decline in the effect of information was sustained by the drop in the number of news stories about the food recall. As the number of stories started to decrease, the size of the information effect started to decline.

After the incorporation of the information index in the PIL model, the net sentiment index was also included in a separate PIL model. The polynomial terms were created using net sentiment index instead of information index. For the ease of comparison with elasticities from the demand system model, this model utilizes log of quantity purchased per week per household as the dependent variable. This study uses a Prais-Winsten and Cochrane-Orcutt log-log regression model. After testing for different combinations, with the use of Akaike Information

Criterion (AIC), results from estimated demand equation for peanut butter are presented in Table 15.

Table 15: Polynomial Inverse Lag Model for Peanut Butter Mean Dependent variable and Net Sentiment Index

Variable	Estimate	Std. Error	t-statistics	P-value
Constant	4.6948	0.2168	21.66	0.00
PPB[a]	-0.8049	0.0875	-9.20	0.00
Pjelly[a]	0.0662	0.0436	1.52	0.13
Pmarm[a]	-0.0556	0.0509	-1.09	0.28
Ppres[a]	-0.0187	0.1013	-0.18	0.85
Pjam[a]	0.0872	0.0658	1.33	0.19
y2[b]	-0.5695	0.2342	-2.43	0.02
y3[b]	1.7802	0.7148	2.49	0.02
y4[b]	-1.1847	0.4808	-2.46	0.02
time	-0.0004	0.0002	-2.49	0.02
ρ1	0.2713			
AIC	-444.3			
R-square	0.5552			
Durbin-Watson	1.81			
N	93			

[a]ppb, pjelly, pmarm, ppres and pjams are the prices for peanut butter, jelly, marmalade, preserves and jams, respectively.
[b]y2, y3, and y4 are the second, third, fourth and fifth degree polynomials using net sentiment index

The estimated price elasticity of demand for the peanut butter was -0.8 and was significant at the one percent level. None of the cross-price elasticities were significant in the model. The polynomial terms up to degree four were significant in the model. The estimates of the polynomial terms were used to construct weights w_i mentioned in equation (4.1). The calculated weights indicate a percentage change in consumption in the respective week. The weekly weights w_i's are plotted against time in Figure 4. The figure shows changes in average weekly consumption of peanut butter, which are analogous to those from the previous model. However, the results for the net sentiment index show a larger decline in the consumption of peanut butter as compared to the results from the information index. The results from the model that includes the net sentiment index show a sharper decline and recovery in demand for peanut butter as compared to the model using information index. The results from second model also showed that within 16-18 weeks of the peak decline in the demand for peanut butter, demand was virtually back to the normal level.

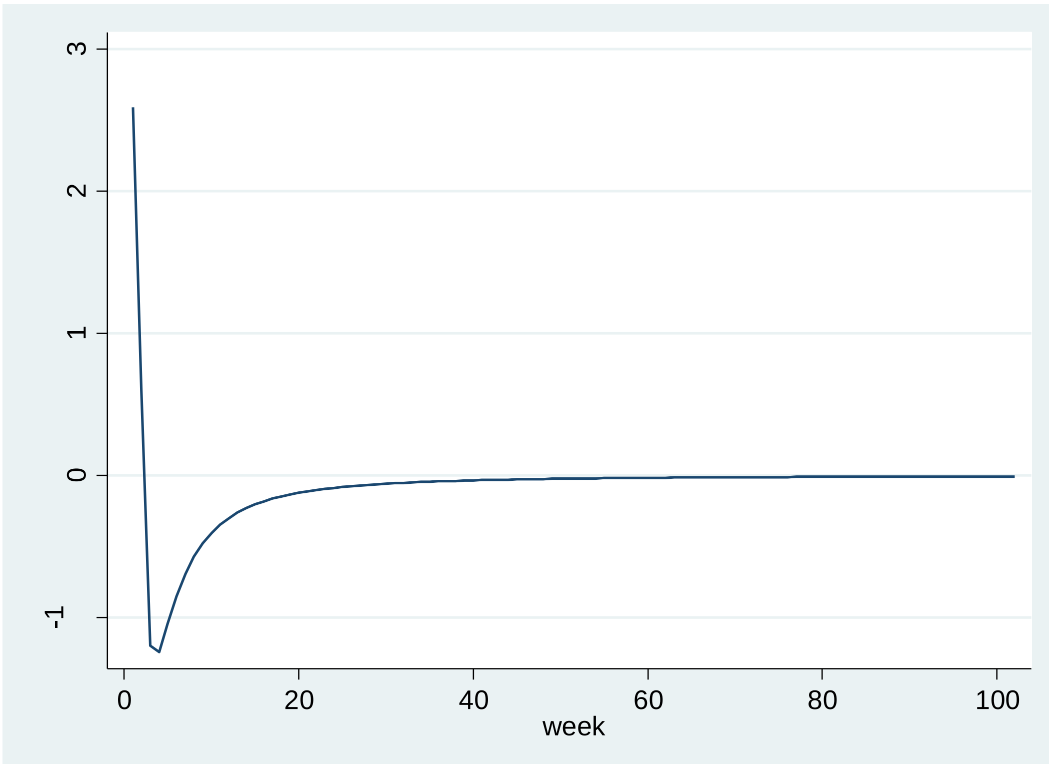

Figure 4: Weekly changes in Peanut Butter Purchases associated with Net Sentiment Index

The estimates from the PIL model suggest that consumption increased by 2.6% in response to the net sentiment index in the first week of the recall. An examination of household purchases revealed that the number of purchases declined for nine weeks following the announcement of the recall; however, the average quantity consumed increased for the first three weeks. The increase in the average consumption may be ascribed to several reasons. The average quantity consumed reflects the exit of consumers making smaller purchases. Information has a lag effect on consumer perception—consumption may only decline after a certain period of time, as the literature suggests. The results from this study corroborate the findings from another study that tested the effect of salmonella contamination on the quantity of peanuts processed by U.S. manufacturers. After plotting historical prices, consumption, production and ending stock values, Wittenberger and Dohlman (2010) found that the use of peanuts declined but returned to previous year levels after four months.

4.2 Cookie Dough Recall of 2009

4.2.1 Demand System Model

Nielsen HomeScan data from years 2008, 2009, and 2010 was used to identify consumer purchases. The data were aggregated on a weekly basis across households. Brand1 was taken off of shelves during the recall period, which lasted from June 19th to August 18th, 2009. The data were divided in two periods, pre-event and post-event period. The descriptive statistics are given in Table 16.

Table 16: Descriptive Statistics for Refrigerated Cookie Dough Quantity and Prices for Pre-event and Post-event Periods

		Quantity (Ounces)		Price (cents/Ounce)	
Pre-event	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Brand1	75	25.79	3.08	6.9	0.41
Brand2	75	25.6	2	7.08	0.39
Store Brand	75	23.46	1.4	5.39	0.21
Other Brand	75	22.19	5.52	7.25	1.47
Post-event	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Brand1	72	25.15	2.18	6.11	0.66
Brand2	72	24.41	1.86	7.07	0.39
Store Brand	72	22.54	1.65	5.61	0.2
Other Brand	72	19.02	3.14	8.2	1.11

In the pre-event period, the average quantity purchased of Brand1, Brand2, Store Brand, and Other Brands were 25.79, 25.59, 23.45, and 22.18 ounces per household per week, respectively. In the post-event period, Brand1 remained the leading cookie dough brand purchased by households in the U.S. in a given week, with an average of 25.14 ounces per household. Brand2 came in at a close second again with 24.40 ounces per household per week. Store Brand and Other Brands remained in third and fourth place, respectively. Households made an average weekly purchase of 22.54 and 19.02 ounces per household of Store Brand and Other Brands, respectively. The order may have remained the same, but the average quantities purchased declined from pre-event to post-event periods across all the brands included in the study. The percentage changes in average quantity purchased per household per week for Brand1, Brand2, Store Brand, and Other Brands were -2.51, -4.65, -3.91, and -14.27 percent, respectively. The standard deviation for the average quantity purchased per week declined for all the brands except Store Brand, suggesting that the variability in quantities purchased decreased from pre-event to post-event period for Brand1, Brand2, and Other Brands.

Table 16 also includes the mean price paid per ounce of refrigerated cookie dough brands in the pre-event and the post-event time period. The Store Brand, Brand1, Brand2, and Other Brands of cookie dough sold for 5.39, 6.89, 7.08, and 7.25 cents per ounce in the pre-event period, respectively. In the post-event period, the average price per ounce of cookie dough for the two major brands decreased, whereas it increased for Store Brand and Other Brands. Brand1 and Brand2 decreased by 11.41 and 0.19 percent. Store Brand and Other Brands increased by 4.02 13.03 and percent. Other Brands and Brand2 remained the highest and second highest priced brands with an average price of 8.19 and 7.06 cents per ounce, followed by Brand1 and the Store Brand, with an average price of 6.10 and 5.6 cents per ounce, respectively.

Figure 5 shows the weekly movement in the sentiment index against the number of media stories published during the respective week. Each story was analyzed using Semantria software and was assigned a score ranging from 2 to -2. The Sentiment index was calculated by taking the net difference between scores of the positive and negative stories aggregated over the week. There are three major dips, where negative sentiment goes above negative 10, which can be viewed in Figure 5. The first big dive in the sentiment index occurred during an announcement of a pet food recall, the second and biggest dive happened during the PCA peanut butter paste recall announcement, and the third big dive in sentiment occurred during an announcement of a shell egg recall.

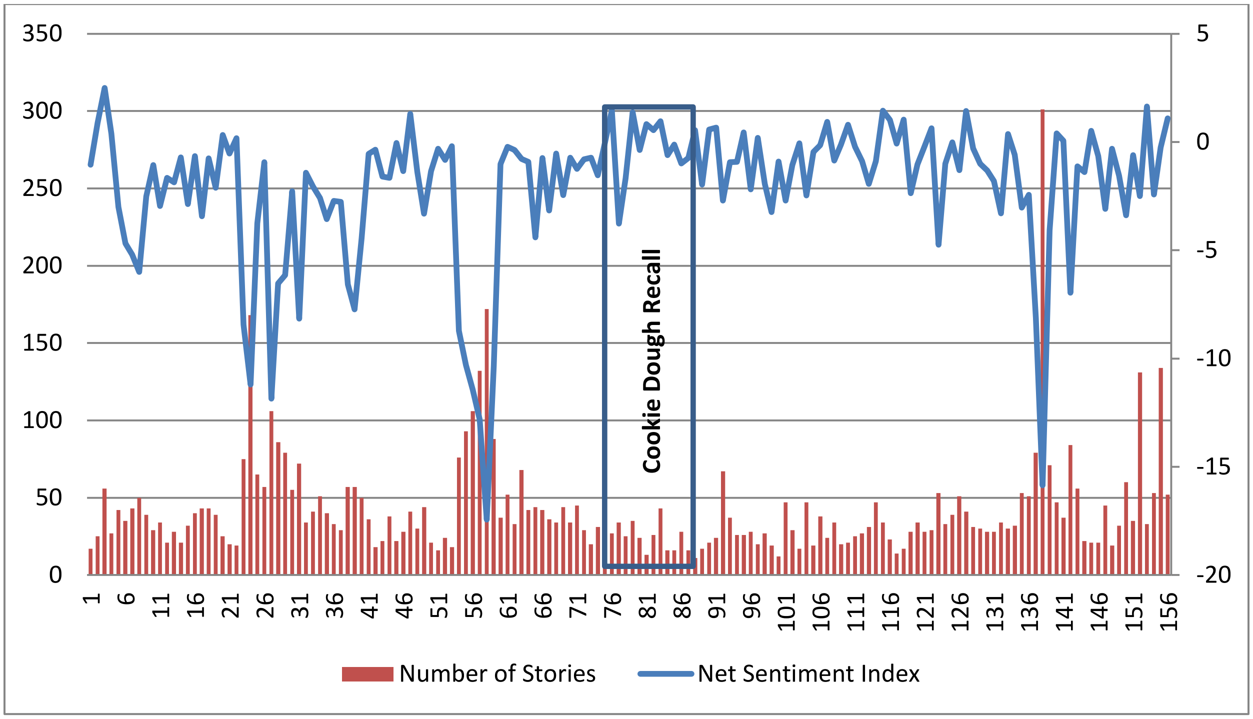

Figure 5: Sentiment Index and Media Story Count

The Brand1 Company announced the recall of all their refrigerated cookie dough products on June 19th, 2009, and the products were taken off the shelf till August 18th, 2009. The sentiment index fell well under zero in the next two weeks following the recall announcement, but it came back and hovered around zero for the rest of the time Brand1 cookie dough was taken off the shelf. The company that produces Brand1was lauded by the media for the way it handled the recall. As soon as the Food and Drug Administration (FDA) listed raw Brand1 cookie dough as a suspect in a case of food contamination, Brand1 announced that it was taking the product off the shelves. Through advertisements and press releases, it also encouraged consumers not to eat the raw cookie dough and return the cookie dough for a refund.

Table 17 presents results of the likelihood ratio tests for the BSM nested model. The results show that in the pre-event period, the Rotterdam and NBR model are rejected but not the CBS or AIDS. The results are similar to Barten (1993), Brown, Lee and Seale (1994) and Matsuda (2005). In the post-event period, the likelihood ratio test rejected all of the four models. It has to be reminisced that Barten's Synthetic model is not just an composite model of the known differential demand systems, but a demand system by itself (Matsuda, 2005). The failure of the likelihood ratio (LR) test to reject CBS and AIDS model does not indicate the weakness of the synthetic model.

Table 17: Test of Nested Models for Refrigerated Cookie Dough in the Pre-event and Post-event Periods

		Pre-event		Post-event	
		χ^2 Statistics	P-value	χ^2 Statistics	P-value
Rotterdam	H0: $\lambda=0$, $\mu=0$	6.56	0.0376	30.48	<.0001
CBS	H0: $\lambda=1$, $\mu=0$	2.23	0.3284	14.57	0.0007
AIDS	H0: $\lambda=1$, $\mu=1$	3.58	0.1668	16.84	0.0002
NBR	H0: $\lambda=0$, $\mu=1$	8.18	0.0167	34.2	<.0001

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Barten's Synthetic model has the same marginal budget shares as generated by specific forms of Engel curves defined in traditional differential demand systems(Matsuda, 2005). This study presents and compares the results from the synthetic model and conventional differential demand systems. However following the argument of Matsuda (2005) for synthetic model to be less biased in its estimates, this study elaborates the results from synthetic model in detail for pre-event and post-event period and compares the elasticity estimates from the four conventional demand systems.

Table 18 presents the results for compensated own-price and cross-price elasticities calculated at the sample mean for the pre-event and the post-event periods.

Table 18: Estimated Compensated Own-Price and Cross-Price Elasticities of Synthetic Model for Refrigerated Cookie Dough Brands in Pre-Event and Post-Event Period

	Brand Name	Brand1	Brand2	Store brand	Other Brands
Pre-event	Brand1	-0.83***	0.41***	0.29***	0.14***
	Brand2	0.40***	-0.58***	0.15**	0.04
	Store brand	0.40***	0.21**	-0.63***	0.02
	Other Brands	0.16***	0.04	0.02	-0.21***
Post-event	Brand1	-0.45***	0.29***	0.06	0.11***
	Brand2	0.25***	-0.53***	0.20**	0.11***
	Store brand	0.08	0.29**	-0.40***	0.03
	Other Brands	0.10***	0.12***	0.03	-0.25***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget shares

The compensated own-price elasticities were statistically significant and satisfied the law of demand in both periods. The compensated own-price elasticities ranged from -0.21 for Other brands to -0.83 for Brand1 in pre-event period. In post-event period they ranged from -0.25 for Other brands to -0.53 for Brand2. The elasticity estimates for all the brands were less than the unity in both the periods, indicating the demand for the cookie dough brands to be inelastic. The magnitude of all the brands except Brand1 did not change by much, but for Brand1 it decreased from the pre- event to the post- event period.

In the pre-event period, except four, all other compensated cross-price elasticities were significant and had a positive sign indicating a substitution effect among the cookie dough brands. The significant substitution effect was present between Brand1 and all the remaining brands. Significant net substitutability was also present between Brand2 and Store brand. In the post-event period, significant net substitutability was absent between Brand1 and Store brand and between Store brand and Other brands. In the pre-event period, net substitutability was strongest between Brand1 and Brand2. In the post-event period, magnitude of substitution effect decreased between Brand1 and Brand2. The substitution effect, which was significant between Brand1 and Store brand in the pre-event period, became insignificant in the post-event period. It is also of interest to notice an increase in the magnitude of substitution effect between Brand2 and Store brand in the post-event period. The magnitude of cross-price elasticity between Brand1 and Other brands declined in the post-event period. Changes in the compensated own-price and cross-price elasticity across the two periods were estimated by using a chi-square test with the null hypothesis that elasticity estimates from the pre-event period are equal to those from the post-event period. These results are presented in Table 19.

Table 19: Test for Differences in the Pre-event and Post-event Elasticities of Refrigerated Cookie Dough

	$\chi 2$ statistics	p-value
Compensated Own-Price Elasticity		
Brand1 = 0.3814	18.84	<.0001
Brand2 = 0.0516	0.23	0.6327
Store brand = 0.2273	2.29	0.1306
Other brands = -0.0438	0.44	0.5072
Compensated Cross-Price Elasticity		
Brand1_ Brand2 = -0.1170	2.00	0.1577
Brand1_Store brand = -0.2261	8.17	0.0032
Brand2_ Brand1= -0.1444	4.04	0.0443
Brand2_Store brand = 0.0526	0.38	0.5360
Store brand_Brand1 = -0.3198	11.45	0.0007
Store brand_Brand2 = 0.0441	0.40	0.5290
Brand1_Other brands = 0.1577	1.61	0.2048
Brand2_Other brands = 0.0426	2.6	0.1071
Sentiment Elasticity		
Brand1 = -0.8407	5.12	0.0237
Other Brands = 0.1083	2.23	0.1355
Expenditure Elasticity		
Brand1 = -0.2178	3.67	0.0554
Brand2 = 0.0278	0.07	0.7970
Store brand = 0.0089	0.00	0.9478
Other Brands = 0.0945	0.89	0.3464

The null hypothesis for the test is that pre-event period elasticity estimates are equal to post-event period. The values next to the brands tested are differences in estimate from pre-event to post-event period.

The changes in the magnitude of elasticity estimates are listed in the first column. The chi-squared tests confirm that only the compensated own-price elasticity for Brand1 changed significantly from the pre-event to post-event periods. The tests for differences in compensated cross-price elasticities indicate a significant change for the substitution effect between Brand1 and Brand2 and between Brand1 and the Store brand. The magnitude of the substitution effect decreased significantly between Brand1 and Brand2 and between Brand1 and the Store brand from pre-event to post-event period. This confirms that consumers were less likely to substitute Brand1 for Brand2 or the Store brand after the recall.

The uncompensated own-price, expenditure and sentiment elasticity estimates for both periods are presented in Table 20. As per expectations, all the uncompensated own-price elasticities from both the periods were significant and negative. Uncompensated own-price elasticity estimates for all the brands except for Other brands decreased from pre-event to post-event period. Demand for Brand1 went from elastic in the pre-event period to inelastic in the post-event period.

Table 20: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Pre-event and Post-event Period of Refrigerated Cookie Dough Brands

	Pre-event			Post-event		
	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Brand 1	-1.05***	0.79***	-0.18	-0.60***	0.57***	-1.02***
Brand 2	-0.71***	0.45***	0.08	-0.67***	0.47***	0.00
Store brand	-0.73***	0.51***	0.00	-0.51***	0.52***	0.06
Other Brands	-0.77***	2.31***	0.11	-0.88***	2.41***	0.96*

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget shares

Expenditure elasticity measures the responsiveness of expenditure on, or consumption of a product to the change in real income, *ceteris paribus* where expenditure is utilized as a proxy for income. Thus, expenditure elasticity measures the percentage change on the demand of a product as total expenditure increases (Tomek and Robinson, 2003). The expenditure elasticity for all the brands was significant and positive for both periods (i.e., both pre and post event). The increase in expenditure elasticity indicates an increase in quantity demanded for cookie products as the expenditure on the cookie products increase, *ceteris paribus*. Brand2 was the least sensitive brand to change in total expenditure in both periods, whereas Other brands was the most sensitive brand to change in total expenditure in both periods. In Table 19, chi-squared tests identifying differences in the expenditure elasticities of two time periods are presented. The tests confirm a significant decline in the expenditure elasticity estimate of Brand1 in the post-event period from the pre-event period.

The Sentiment elasticities presented in Table 20 were calculated using two lags of the net sentiment index. Sentiment elasticity did not have a significant effect in the pre-event period However, in the post-event period, the sentiment elasticity for Brand1 was significant and negative. The sentiment elasticity for Other brands was also significant and positive. The results demonstrate that in the post recall period media information and the tone of that information did seem to have an adverse effect on the consumption of Brand1 cookie dough products. Negative media coverage on the recall of Brand1 cookie dough appears to have benefitted the consumption of Other brands as indicated by the positive sign on the estimates of sentiment elasticity.

A separate demand system model was estimated using the information index which considers for the effect number of stories published. Another model was tested by incorporating separate sentiment indices to identify the differences between positive and negative information. Results for the own-price, cross-price, uncompensated and expenditure elasticities are very similar to the results obtained from the demand system model using the net sentiment index measure. Elasticity estimates are presented in the appendix with parameter estimates for the remaining two models. The results for the sentiment, information and positive and negative elasticities for pre-event and post-event periods are reported in the Table 21.

Table 21: Estimated Sentiment, Information and Positive and Negative Elasticities for Pre-event and Post-Event Refrigerated Cookie Dough Brands

		Sentiment Elasticity	Information Elasticity	Negative Sentiment Elasticity	Positive sentiment Elasticity
Pre-event	Brand1	-0.18	-0.01	-0.16	1.37
	Brand2	0.08	-0.01	0.07	-0.57
	Store brand	0.00	0.01	-0.02	-0.10
	Other brands	0.11	0.02	0.12	-0.72
Post-event	Brand1	-1.02***	-0.03*	-1.00**	0.37
	Brand2	0.00	0.01	0.00	0.47
	Store brand	0.06	0.00	-0.04	1.24
	Other brands	0.96*	0.02	1.02	-1.91

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at mean budget shares

The results from the pre-event period show that none of the media indices had any noticeable effect on the brands involved in the analysis. In the post-event period similar to sentiment elasticity, information elasticity and negative sentiment elasticity had a significant negative effect on the demand of the brands analyzed. The Net sentiment index had positive elasticity for Other brands, indicating that Other brands was benefited after the Brand1 related food safety event. However, none of the remaining media indices had an effect on Other brands.

The results also indicate that net sentiment index and negative sentiment index had a larger effect on the demand of Brand1 than information index.

The likelihood ratio tests for the nested models failed to reject AIDS and CBS model in the pre-event period. This study tests all four conventional demand systems and compares the results to synthetic model. The synthetic model nests four specific functional forms in it, based on the combination of values of λ and μ set equal to 0 or 1. More functional forms can be obtained by imposing different restrictions on λ and μ. The synthetic model has two more parameters than specific functional forms, which makes it slightly more flexible. The synthetic model becomes a Rotterdam model when both λ and μ are restricted to be zero, the CBS model when λ=1 and μ=0, the AIDS model when λ =1 and μ=1, and the NBR model when λ =0 and μ=1. With a change in expenditure shares, the marginal budget shares for the Rotterdam and NBR models remain constant and vary for the AIDS and CBS models, while the Slutsky term remains constant for the Rotterdam and CBS models and vary for the AIDS and NBR models.

The results for joint hypothesis tests of different combination of λ and μ for both periods are presented in Table 17. The results show that the synthetic model rejected all four models in the post-event period. However, in the pre-event period, the synthetic model rejected Rotterdam and NBR models but could not reject AIDS and CBS model. The results are similar to previous studies which compare the synthetic model against differential demand systems (Barten, 1993, Brown, et al., 1995, Matsuda, 2005, Yuan, et al., 2009). The results for compensated own-price and cross-price elasticities estimated at the sample mean are presented in Table 22. The compensated price elasticities obtained from $\epsilon_{ij}^{c} = \frac{\gamma_{ij}}{w_i} - \mu\left(\delta_{ij} - w_i\right)$ are a function of budget shares. Looking at the pre-event compensated price elasticities in this study, we were not able find any noticeable differences between price elasticities of two time periods.

Table 22: Estimated Compensated Own-Price and Cross-Price Elasticities at the Sample Mean for Pre-event and Post-event Period Refrigerated Cookie Dough Brands

		Pre-event				Post-event			
Model	Brand Name	Brand1	Brand2	Store brand	Other Brands	Brand1	Brand2	Store brand	Other Brands
Synthetic	Brand1	-0.83***	0.41***	0.29***	0.14***	-0.45***	0.29***	0.06	0.11***
	Brand2	0.40***	-0.58***	0.15**	0.04	0.25***	-0.53***	0.20**	0.11***
	Store brand	0.40***	0.21**	-0.63***	0.02	0.08	0.29**	-0.40***	0.03
	Other Brands	0.16***	0.04	0.02	-0.21***	0.10***	0.12***	0.03	-0.25***
Rotterdam	Brand1	-0.84***	0.41***	0.29***	0.14***	-0.42***	0.28***	0.08	0.07
	Brand2	0.40***	-0.59***	0.16**	0.03	0.25***	-0.49***	0.17**	0.10**
	Store brand	0.40***	0.23**	-0.64***	0.01	0.1	0.24**	-0.37**	0.05
	Other Brands	0.16***	0.03	0	-0.20**	0.07	0.12**	0.04	-0.21***
CBS	Brand1	-0.84***	0.41***	0.29***	0.14***	-0.42***	0.28***	0.07	0.08*
	Brand2	0.40***	-0.59***	0.15**	0.03	0.25***	-0.50***	0.18**	0.10**
	Store brand	0.40***	0.22**	-0.63***	0.01	0.09	0.26**	-0.38**	0.05
	Other Brands	0.16***	0.04	0.01	-0.20**	0.08*	0.12**	0.04	-0.22***
AIDS	Brand1	-0.82***	0.39***	0.29***	0.14***	-0.44***	0.29***	0.08	0.08**
	Brand2	0.38***	-0.58***	0.16**	0.04	0.25***	-0.52***	0.19**	0.11***
	Store brand	0.39***	0.23**	-0.64***	0.02	0.1	0.26**	-0.39**	0.05
	Other Brands	0.16***	0.04	0.01	-0.21***	0.08**	0.12***	0.04	-0.23***
NBR	Brand1	-0.82***	0.39***	0.29***	0.14***	-0.44***	0.29***	0.08	0.07*
	Brand2	0.38***	-0.58***	0.17**	0.03	0.26***	-0.50***	0.17**	0.11**
	Store brand	0.39***	0.24**	-0.65***	0.01	0.1	0.24**	-0.37**	0.05
	Other Brands	0.16***	0.04	0.01	-0.21**	0.07*	0.12**	0.04	-0.21***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level

The results for uncompensated own-price, expenditure and sentiment elasticities estimated at the sample mean are presented in Table 23.

Table 23: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities at the Sample Mean for Pre-Event and Post-Event Period Refrigerated Cookie Dough Brands

		Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Synthetic	Brand1	-1.05***	0.79***	-0.18	-0.60***	0.57***	-1.02***
	Brand2	-0.71***	0.45***	0.08	-0.67***	0.47***	0.00
	Store brand	-0.73***	0.51***	0.00	-0.51***	0.52***	0.06
	Other Brands	-0.77***	2.31***	0.11	-0.88***	2.41***	0.96*
Rotterdam	Brand1	-1.05***	0.75***	-0.17	-0.53***	0.44***	-0.99**
	Brand2	-0.71***	0.41***	0.02	-0.62***	0.43***	0.02
	Store brand	-0.73***	0.45***	-0.11	-0.43***	0.32**	0.14
	Other Brands	-0.78***	2.45***	0.29	-0.92***	2.77***	0.95
CBS	Brand1	-1.06***	0.77***	-0.17	-0.54***	0.47***	-1.00**
	Brand2	-0.71***	0.42***	0.04	-0.63***	0.44***	0.02
	Store brand	-0.73***	0.48***	-0.06	-0.46***	0.39***	0.12
	Other Brands	-0.77***	2.41***	0.23	-0.91***	2.68***	0.94
AIDS	Brand1	-1.03***	0.76***	-0.18	-0.57***	0.49***	-1.01**
	Brand2	-0.71***	0.45***	0.07	-0.65***	0.45***	0.01
	Store brand	-0.74***	0.48***	-0.06	-0.47***	0.37***	0.1
	Other Brands	-0.78***	2.37***	0.21	-0.90***	2.63***	0.98
NBR	Brand1	-1.02***	0.74***	-0.17	-0.55***	0.45***	-1.00**
	Brand2	-0.71***	0.44***	0.04	-0.63***	0.44***	0.00
	Store brand	-0.74***	0.47***	-0.11	-0.43***	0.30***	0.12
	Other Brands	-0.79***	2.41***	0.27	-0.91***	2.75***	0.99

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level

The expenditure elasticity for the synthetic model and specific functional forms was obtained from $\epsilon_i = \frac{\beta_i}{w_i} + \lambda$. In the Rotterdam and NBR models where λ =0 with an increase in expenditure level, elasticities of necessities rise and those of luxuries fall. For AIDS and CBS models where $\lambda = 1$, the expenditure elasticity never increases with an increase in expenditure level. Usually when λ takes a value between zero and unity, expenditure elasticity increases with an increase in the expenditure level (Matsuda, 2005).

Although the synthetic model rejected both Rotterdam and NBR models, which have a linear form of Engel curves, it also failed to reject the CBS and AIDS models that have linear logarithmic Engel curves. This study was not able find differences in the expenditure elasticities of these models. The expenditure elasticity of Brand1 for the rejected models was slightly smaller than the synthetic model and the expenditure elasticity of Other brands was slightly larger than for the synthetic model.

4.2.2 Polynomial Inverse Lag Model

The effect of information over the demand for refrigerated cookie dough was analyzed by using a Polynomial Inverse Lag (PIL) model. The recall for Brand1 officially ended on August 18th, 2009 and Brand1 was introduced back on the shelves. The log of quantity of Brand1 purchased per week per household was used as the dependent variable in the model similar to the demand system model. The log price of Brand1 was included as an explanatory variable along with the prices of remaining brands - Brand2, Store Brand and Other Brands. The results for the Breusch–Godfrey test rejected the null hypothesis of no serial correlation and the results of Durbin-Watson test after a general OLS model showed that the model requires an autoregressive correction. A Prais-Winsten and Cochrane-Orcutt regression with first order autoregressive process was used to correct for autocorrelation. After testing for different combinations, with the use of Akaike Information Criterion (AIC), the estimates obtained from the demand equation for Brand1 cookie dough are presented in Table 24.

Table 24: Polynomial Inverse Lag model for Brand1 Refrigerated Cookie Dough with Information Index

Variable	Estimate	Std. Error	t-statistics	P-value
Constant	3.0384	0.5327	5.7000	0.0000
lPBrand1[a]	-0.4585	0.1603	-2.8600	0.0060
lPBrand2[a]	0.3744	0.2293	1.6300	0.1090
lPStore[a]	0.1852	0.2021	0.9200	0.3640
lPOther[a]	-0.0038	0.0851	-0.0500	0.9640
z2[b]	-0.5851	0.7151	-0.8200	0.4170
z3[b]	4.3257	4.5664	0.9500	0.3480
z4[b]	-8.3873	8.7472	-0.9600	0.3420
z5[b]	4.6479	4.8937	0.9500	0.3470
ρ1	0.4564			
AIC	-136.7371			
R-square	0.2066			
Durbin-Watson	2.1932			
Obs	60			

[a]lPBrand1, lPBrand2, lPStore, and lPOther are log prices of Brand1, Brand2, Store Brand, and Other brands.
[b]z2, z3, and z4 are the second, third, fourth and fifth degree polynomials

Only the log price of Brand1 had a significant effect on the consumption of Brand1 cookie dough products. The own-price elasticity of Brand1 was -0.45 in the PIL model, which was same as own-price elasticity from demand system model. The coefficients for all the polynomial terms in the equation were insignificant.

After incorporating sentiment indices in the demand system model, the net sentiment index was incorporated in the Polynomial Inverse Lag model. The polynomial terms were created by using the net sentiment index instead of the information index. For ease of comparison with elasticities from the demand system model, this model utilizes the log of quantity purchased per week per household as the dependent variable. Prais-Winsten and Cochrane-Orcutt log-log regression model was used to correct for autocorrelation. The transformed Durbin-Watson statistic is presented in Table 25. After testing for different combinations with the use of Akaike Information Criterion (AIC), the estimated results are also presented in Table 25.

Table 25: Polynomial Inverse Lag Model for Brand1 Refrigerated Cookie Dough with Net Sentiment Index

Variable	Estimate	Std. Error	t-statistics	P-value
Constant	3.1507	0.5245	6.01	0.000
lPBrand1[a]	-0.4215	0.1448	-2.91	0.005
lPBrand2[a]	0.3522	0.2317	1.52	0.135
lPStore[a]	0.1056	0.1896	0.56	0.580
lPOther[a]	-0.006	0.0853	-0.07	0.944
y2[b]	0.8398	1.645	0.51	0.612
y3[b]	-7.7921	11.2405	-0.69	0.491
y4[b]	18.6579	22.5735	0.83	0.412
y5[b]	-11.663	12.9517	-0.90	0.372
ρ1	0.4517			
AIC	-134.35			
R-square	0.2008			
Durbin-Watson	2.19			
Obs	60			

[a]lPBrand1, lPBrand2, lPStore, and lPOther are log prices of Brand1, Brand2, Store Brand, and Other brands.
[b]y2, y3, y4 and y5 are the second, third, fourth and fifth degree polynomials created using net sentiment index.

The estimated own-price elasticity of demand for the Brand1 was -0.42 and was significant at the one percent level. The estimate for own-price elasticity of Brand1 from polynomial inverse lag model was equivalent to own-price elasticity estimate from the demand system model.

The study was unable to find any significant polynomial terms in the model. The insignificance of the model's polynomial terms restricted us from creating weights as a means of identifying identify the weekly changes in the demand for Brand1 cookie dough.

The demand system model was able to find a long term effect of information on the demand for Brand1. However, in the PIL model the study was not able to find a weekly reduction in Brand1 demand. After the announcement of the recall, Brand1 was quickly taken off store shelves on June 18th, 2009 and returned to shelves on August 18th, 2009. The parent company for Brand1 cookie dough responded quickly and handled the recall efficiently, which limited media coverage for the recall associated with Brand1 cookie dough.

4.3 Gulf Oil Spill Event

4.3.1 <u>Demand System Model</u>

The data used in this study were for the years 2008, 2009 and 2010. Table 26 includes the results for the descriptive statistics for the mean quantities purchased per household per week and mean price paid in cents per ounce per household per week.

Table 26: Descriptive Statistics for Meat Products Quantity and Prices

		Quantity (Ounces)		Price (cents/Ounce)	
	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Frozen Seafood	156	30.38	0.93	13.56	0.83
Frozen Poultry	156	73.22	1.99	5.91	0.17
Frozen Beef	156	59.59	5.86	7.41	0.54
Frozen Pork	156	24.15	0.87	9.50	0.77
Fresh Meat	156	47.75	2.08	6.52	0.23
Frozen Other	156	39.85	28.47	6.70	1.91

The average quantity purchased of frozen poultry was 73.22 ounces (4.25 pounds) per household per week, which was the highest among all the product categories. Frozen pork had the lowest average quantity purchased with 24.15 ounces per household per week. The remaining products in ascending order of the average quantity purchased per household per week were frozen seafood (30.28), frozen other (39.85), fresh meat (47.75), and frozen beef (59.59). The standard deviation for all the products, except frozen other, ranged from 0.87 to 5.86. For the frozen other category it was much higher at 28.47, which might suggest concern for the stationarity of the data series. However, the result from the augmented Dickey-Fuller and Phillips-Perron tests confirmed that all the variables used in the study were stationary. Furthermore, the demand system used for the study was a differential demand system, which takes first differences of the data points, thus taking care of any issues related to non-stationary data.

Frozen seafood had the highest average price paid among all the product categories with 13.56 cents per ounce per household per week, whereas frozen poultry was the lowest at 5.91 cents per ounce per household per week. The remaining products are, in ascending order of average price paid, fresh meat (6.52), frozen other (6.70), frozen beef (7.41), and frozen pork (9.50).

A joint hypothesis test was conducted for different combinations of λ and μ by using values of 1 and 0. The different combinations provide differential versions of the four demand systems which are nested in the general Barten's Synthetic Model. The results for the joint hypothesis tests of λ and μ are presented in Table 27. The results support the use of Barten's Synthetic Model. The model was corrected for autocorrelation using the AR2 model.

Table 27: Test of Nested Models for Meat Products

Model	Statistic	Pr > ChiSq	Label
Rotterdam	91.83	<.0001	λ=0, μ=0
CBS	57.17	<.0001	λ=1, μ=0
AIDS	18.74	<.0001	λ=1, μ=1
NBR	50.51	<.0001	λ=0, μ=1

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at α = 0.05

The results for compensated own-price and cross-price elasticities for the meat products during the study period are listed in Table 28. All the elasticities were calculated at the sample means of the budget shares. The compensated own-price elasticities are expected to be negative and the cross-price elasticities are expected to be positive since meat products are considered to be normal goods and substitutes of each other. Expenditure elasticities are expected to be positive.

The compensated own-price elasticity indicates a percent change in the quantity demanded of the product with a percent change in the price. All the compensated own-price elasticities were significant and negative, satisfying the law of demand. The own-price elasticity for other meat product was highest in magnitude with -0.81, indicating that it was most price responsive of all the product categories. The own-price elasticity for frozen seafood (-0.13) was the least price sensitive.

Table 28: Compensated Own-Price and Cross-Price Elasticity for Meat Products

	Frozen Seafood	Frozen Poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.13**	-0.11**	0.05	0.02	0.07*	0.10***
Frozen Poultry	-0.12**	-0.33***	0.20***	0.12***	0.04	0.08***
Frozen Beef	0.05	0.17***	-0.70***	0.14***	0.19***	0.15***
Frozen Pork	0.03	0.16***	0.20***	-0.70***	0.23***	0.09***
Fresh Meat	0.08*	0.05	0.24***	0.19***	-0.66***	0.10***
Frozen Other	0.16***	0.13***	0.26***	0.11***	0.15***	-0.81***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level
All elasticities are calculated at the sample mean

The results from cross-price elasticities indicated a strong substitution effect among all the frozen meat product categories, except the frozen seafood, which did not have significant cross-price elasticity for frozen beef and frozen pork. The cross-price elasticity for frozen seafood and frozen poultry was negative indicating that they are complements. Capps and Schmitz (1991) found cross-price elasticity for poultry and fish to be negative and significant (Capps and Schmitz, 1991). Kinnucan et al. (1997) also found the cross-price elasticities for poultry and fish to be negative, but insignificant.

Uncompensated own-price elasticities for all the meat products are presented in Table 29. Similar to the compensated own-price elasticities (Table 28), frozen other meat category was the most price sensitive, and frozen seafood was the least price sensitive of all the meat products.

Table 29: Uncompensated Own-Price, Expenditure and Sentiment Elasticity for Meat Products

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Frozen Seafood	-0.2436***	0.5814***	0.0192
Frozen Poultry	-0.3896***	0.3339***	0.2597*
Frozen Beef	-0.8506***	0.7447***	-0.0851
Frozen Pork	-0.8103***	0.8055***	-0.1066
Fresh Meat	-0.7918***	0.7665***	-0.1839
Frozen Other	-1.2433***	3.7894***	0.1185

Expenditure elasticity measures the responsiveness of expenditure on, or consumption of a product to the change in real income, *ceteris paribus* where expenditure is proxy for income. Thus expenditure elasticity measures the percentage change on a product expenditure as total expenditure increases (Tomek and Robinson, 2003). The positive expenditure elasticity indicates an increase in quantity demanded for meat products as the expenditure on the meat products increased, *ceteris paribus*. The expenditure elasticity for frozen other was the most elastic among all the meat products. As the total expenditure on the meat products increases by one percent, frozen other meat has a higher percentage increase in the share of expenditure than the rest of the meat categories. Capps and Schmitz (1991), using four meat categories (Beef, Pork, Poultry, and Fish), found similar results. Even the order of the magnitude of the expenditure elasticity is the same, with poultry being most inelastic, followed by fish, beef and pork (Capps and Schmitz, 1991).

This study incorporated the interaction variable between the net sentiment index and Gulf oil spill dummy in the model. A dummy variable was constructed to identify the time period after the Deepwater Horizon explosion, by differentiating between the time period before and after the oil spill.

The sentiment elasticity was only statistically different from zero for the frozen poultry equation. The positive results are similar to the previous literature. Capps and Schmitz (1991) found that a cholesterol information index has a positive effect on the poultry and fish consumption and a negative effect on pork. Kinnucan et al. (1997) found that a health information index had a marginally significant positive effect on poultry consumption whereas it had a negative effect on beef consumption. Most of the frozen meat products have a long term shelf life as compared to fresh products, which also makes it possible for them to be imported from long distances. This study also utilizes weekly data, unlike some other studies which have used monthly, quarterly or annual data (Verbeke and Ward 2001, Kinnucan et al. 1997).

Table 30 presents elasticity estimates for net sentiment, information and positive and negative index. The information elasticity was calculated using up to the first lag of information index and the model was corrected using AR1 model.

Table 30: Net Sentiment, Information, and Positive and Negative sentiment Elasticities for Meat Products

	Sentiment Elasticity	Information Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Frozen Seafood	0.019	0.002	-0.045	0.185
Frozen poultry	0.260*	-0.005	0.072	1.266*
Frozen Beef	-0.085	-0.001	0.006	-0.691
Frozen Pork	-0.107	0.006	-0.066	-0.496
Fresh Meat	-0.184	0.009	-0.235*	0.432
Frozen Other	0.119	-0.014	0.372	-1.075

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean, The elasticity estimates of three media indices are computed using a interaction term with dummy variable denoting period after recall.

The separate sentiment elasticities were calculated using up to the first lag of the negative sentiment index and no lag for the positive sentiment index based on the likelihood ratio test. The model is corrected for autocorrelation using the AR2 model. The results for the parameter estimates and the compensated own-price and cross-price elasticities, uncompensated and expenditure elasticities were very similar to the previous model. Thus, this section focuses mostly on the results for the separated sentiment elasticities. The results for the parameter estimates are included in the appendix.

The results of the positive sentiment elasticity indicate that the tone of the information encouraged consumers to move towards frozen poultry products. However, this study was unable to find the effect of food recall information on the consumption of frozen seafood products after the Gulf oil spill was announced.

Similar to previous cases, this study compares the demand elasticities from the pre-event to post-event periods in order to identify the structural change (if any) that occurred in the demand for the products studied. Table 31 includes the results for the descriptive statistics for the mean quantities purchased per household per week and mean prices paid in cents per ounce per household per week for both the periods.

Table 31: Descriptive Statistics for Meat Products Quantity and Prices for Pre-event and Post-event period

		Quantity (Ounces)		Price (cents/Ounce)	
Pre-Event	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Frozen Seafood	119	30.24	0.89	13.51	0.88
Frozen Poultry	119	73.15	2.00	5.93	0.17
Frozen Beef	119	59.51	5.78	7.39	0.57
Frozen Pork	119	24.41	0.75	9.15	0.30
Fresh Meat	119	48.20	2.04	6.46	0.22
Frozen Other	119	38.82	25.12	6.49	1.74
Post-Event	Weeks	Mean	Std. Dev.	Mean	Std. Dev.
Frozen Seafood	38	30.83	0.91	13.71	0.63
Frozen Poultry	38	73.41	1.98	5.87	0.16
Frozen Beef	38	59.86	6.14	7.50	0.45
Frozen Pork	38	23.35	0.74	10.58	0.77
Fresh Meat	38	46.36	1.48	6.69	0.15
Frozen Other	38	43.13	36.99	7.33	2.29

In the pre-event period, the average quantity purchased of frozen poultry was 73.22 ounces per household per week, which was the highest among all the product categories. Frozen pork had the lowest average quantity purchased with 24.41 ounces per household per week. Frozen seafood had the highest average price paid among all the product categories at 13.51 cents per ounce per household per week, whereas frozen poultry was the lowest at 5.93 cents per ounce per household per week.

In the post-event period average quantity purchased of frozen poultry was 73.41 ounces per household per week, which was again the highest among all the product categories. Similarly frozen pork had the lowest average quantity purchased with 23.35 ounces per household per week. Frozen seafood had the highest average price paid among all the product categories with 13.71 cents per ounce per household per week, whereas frozen poultry was the lowest with 5.87 cents per ounce per household per week.

Table 32 presents the results of the likelihood ratio tests for the BSM nested model. The results show that in the pre-event period and the post-event period all four conventional models, i.e., the Rotterdam, CBS, AIDS and NBR, were rejected in favor of Barten's synthetic model.

Table 32: Test of Nested Models for Meat Products in the Pre-event and Post-event Periods

		Pre-event		Post-event	
		χ^2 Statistics	P-value	χ^2 Statistics	P-value
Rotterdam	H0: $\lambda=0$, $\mu=0$	80.43	<.0001	51.61	<.0001
CBS	H0: $\lambda=1$, $\mu=0$	54.01	<.0001	34.48	<.0001
AIDS	H0: $\lambda=1$, $\mu=1$	24.17	<.0001	24.26	<.0001
NBR	H0: $\lambda=0$, $\mu=1$	47.33	<.0001	39.83	<.0001

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

The own-price and the cross-price elasticities for pre-event and post-event periods are presented in Table 33. The compensated own-price elasticities were not statistically significant for frozen seafood and frozen poultry in post-event period. The statistically significant compensated own-price elasticities satisfied the law of demand in both periods. The elasticity estimates for all the meat products were less than unity in both the periods, indicating the demand for the meat products to be inelastic.

Table 33: Own-Price and Cross-price elasticities of Meat products for Synthetic model with Net Sentiment Index

		Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Pre-Event	Frozen Seafood	-0.22***	-0.05	0.11**	0.01	0.06	0.09***
	Frozen poultry	-0.04	-0.45***	0.26***	0.08***	0.06	0.09***
	Frozen Beef	0.10**	0.26***	-0.76***	0.10***	0.16***	0.14***
	Frozen Pork	0.02	0.16***	0.20***	-0.72***	0.27***	0.07***
	Fresh Meat	0.08	0.08	0.23***	0.19***	-0.68***	0.10***
	Frozen Other	0.17***	0.18***	0.28***	0.07**	0.15***	-0.86***
Post-Event	Frozen Seafood	0.19	-0.18	-0.02	-0.07	0	0.08*
	Frozen poultry	-0.18	-0.04	0.1	0.1	-0.04	0.06
	Frozen Beef	-0.02	0.1	-0.49***	0.11***	0.16***	0.14***
	Frozen Pork	-0.12	0.17	0.20***	-0.43***	0.13	0.04
	Fresh Meat	0	-0.06	0.24***	0.11***	-0.39**	0.10**
	Frozen Other	0.15*	0.11	0.25***	0.04	0.13**	-0.68*

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Results also show that the magnitude of significant own-price elasticity estimates decreased from pre-event to post-event period. The results for tests confirming the statistical significance of the change in magnitudes of compensated own-price and cross-price elasticities are presented in Table 35.

The uncompensated own-price, expenditure and sentiment elasticity estimates for both periods are presented in Table 34. As per the expectations, all the significant uncompensated own-price elasticities from both the periods were negative. Expenditure elasticity for frozen other meat was the most elastic among all the meat products in both the periods. As the total expenditure on the meat products increases by one percent, frozen other meat has a higher percentage increase in the share of expenditure than the rest of the meat categories.

Table 34: Uncompensated, Expenditure and Net Sentiment Elasticities of Meat products for Synthetic Model

		Uncompensated Elasticity	Expenditure Elasticity	Net Sentiment Elasticity
Pre-Event	Frozen Seafood	-0.35***	0.66***	0.00
	Frozen poultry	-0.59***	0.66***	0.07
	Frozen Beef	-0.93***	0.78***	-0.01
	Frozen Pork	-0.78***	0.50***	0.00
	Fresh Meat	-0.78***	0.67***	0.13
	Frozen Other	-1.26***	3.75***	-0.28
Post-Event	Frozen Seafood	0.07	0.58***	0.15
	Frozen poultry	-0.18	0.66***	0.06
	Frozen Beef	-0.72***	1.05***	0.25
	Frozen Pork	-0.45***	0.2	-0.08
	Fresh Meat	-0.50***	0.74***	-0.24
	Frozen Other	-1.07***	3.40***	-0.41

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

To detect significant changes in the compensated own-price and cross-price elasticity across the two periods, this study conducted a chi-square test with a null hypothesis that elasticity estimates from the pre-event period are equal to those from the post-event period. The results for chi-squared tests are presented in Table 35.

Table 35: Test for differences in Pre-event and Post-event period Elasticities of Meat Products

	$\chi 2$ statistics	p-value
Compensated Own-Price Elasticity		
Frozen Beef= 0.2676	19.49	<.0001
Frozen Pork= 2975	33.51	<.0001
Fresh Meat= 0.2905	22.27	<.0001
Frozen Other= 0.1809	4.22	0.0399
Cross-Price Elasticity		
Frozen Seafood_Frozen Other= -0.006	0.06	0.8046

Table 35 continued

Frozen Other_Frozen Seafood= -0.024	0.20	0.6574
Frozen Beef_Frozen Pork= -0.007	0.12	0.7325
Frozen Beef_FreshMeat= -0.003	0.01	0.9143
Frozen Beef_Frozen Other= -0.002	0.01	0.9088
Frozen Pork_Frozen Beef= -0.001	0.00	0.9654
Fresh Meat_Frozen Beef= 0.010	0.06	0.8025
Frozen Other_Frozen Beef= -0.028	0.23	0.6281
Fresh Meat_Frozen Other= -0.003	0.01	0.9305
Frozen Other_Fresh Meat= -0.021	0.19	0.6643
Uncompensated Elasticity		
Frozen Beef= 0.2123	12.86	0.0003
Frozen Pork= 0.3295	39.29	<.0001
Fresh Meat= 0.2831	20.67	<.0001
Frozen Other= 0.1894	11.77	0.0006
Expenditure Elasticity		
Frozen Seafood= -0.0818	0.67	0.4133
Frozen Poultry= -0.001	0.00	0.9894
Frozen Beef= 0.2683	7.91	0.0049
Fresh Meat= 0.074	0.55	0.4579
Frozen Other= -0.35	1.18	0.2766

The null hypothesis for the test is that pre-event period elasticity estimates are equal to post-event period. The values next to the products tested are differences in estimate from pre-event to post-event period.

The test for differences between pre-event and post-event elasticities found compensated own price elasticities for frozen beef, frozen pork, fresh meat and frozen other to be significantly different. Magnitude for frozen beef, frozen pork, fresh meat and frozen other declined in the post-event period indicating that demand for frozen beef, frozen pork, fresh meat and frozen other became more inelastic. This study was unable find any significant differences in the cross-price elasticities from the pre-event to post-event periods. Similar to compensated own-price elasticities, the uncompensated own-price elasticities for frozen beef, frozen pork, fresh meat and frozen other were also significantly different in the post-event period as compared to the pre-event period. This study found that only expenditure elasticity for frozen beef was significantly different in the post-event period compared to the pre-event period. Demand for frozen beef became elastic in the post-event period.

A separate demand system model was estimated using the information index created by using the number of stories published that related to a particular incident. The information elasticity was calculated using up to the second lag of the information index. . The results for the sentiment, information and positive and negative elasticities for pre-event and post-event periods are reported in the Table 36.

Table 36: Estimated Sentiment, Information and Positive and Negative Elasticities of Meat Products for Pre-Event and Post-Event Periods

		Net Sentiment Elasticity	Information Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Pre-Event	Frozen Seafood	0.000	0.004	0.119	0.213
	Frozen poultry	0.070	-0.005	0.047	0.167
	Frozen Beef	-0.010	-0.006	0.090	-0.257
	Frozen Pork	0.000	0.002	-0.024	-0.161
	Fresh Meat	0.130	-0.003	-0.028	-0.189
	Frozen Other	-0.280	0.020	-0.394	0.224
Post-Event	Frozen Seafood	0.150	-0.002	0.444***	-1.254**
	Frozen poultry	0.060	-0.004	-0.300	1.661***
	Frozen Beef	0.250	0.005	0.209	-0.864
	Frozen Pork	-0.080	-0.002	-0.056	-0.494**
	Fresh Meat	-0.240	-0.008	0.173	-1.146
	Frozen Other	-0.410	0.016	-0.760	2.811

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Another model was also tested by incorporating separate sentiment indices to identify the differences between positive and negative information. The negative sentiment elasticity was calculated using up to the second lag and the positive sentiment elasticity was calculated using positive sentiment index at no lag. The results for the own-price, cross-price, uncompensated and expenditure elasticities from these models are very similar to those results obtained from the demand system model using a net sentiment index. The elasticity estimates are presented in the appendix along with parameter estimates for the remaining two models

Similar to the net sentiment index, this study was unable to find a significant effect for information index in both periods. The Positive sentiment index had a negative effect on the demand for frozen seafood and frozen pork and a positive effect on the demand for frozen poultry in the post-event period. The negative sentiment index had a positive effect on the demand for frozen seafood in the post-event period.

4.3.2 Polynomial Inverse Lag Model

The study also made an effort to identify the effect that information had on the demand for frozen seafood products using a Polynomial Inverse lag model. The dependent variable in the model was the log of quantity purchased per week per household of frozen seafood similar to the demand system model. The log price of frozen seafood was included as an explanatory variable along with the prices for other products - frozen poultry, beef, pork, fresh meat and other frozen products. The results for the Breusch–Godfrey test rejected the null hypothesis of no serial correlation and the results of Durbin-Watson test after a general OLS model showed that the model required autoregressive correction.

A Prais-Winsten and Cochrane-Orcutt regression with first order autoregressive process were used to correct for autocorrelation. As the Gulf oil spill started on April 20th, 2010, the data used in this study cover that post event period. The estimates of polynomial inverse Lag model for frozen seafood with information index are presented in table 37.

Table 37: Polynomial Inverse Lag Model for Frozen Seafood with Information Index

Variable	Estimate	Std. Error	t-statistics	P-value
Constant	4.6713	1.1696	3.9900	0.0010
lnp1[a]	-0.1142	0.2473	-0.4600	0.6500
lnp2[a]	-0.7150	0.1853	-3.8600	0.0010
lnp3[a]	-0.1541	0.1791	-0.8600	0.4020
lnp4[a]	-0.1868	0.1676	-1.1100	0.2810
lnp5[a]	0.4904	0.4390	1.1200	0.2800
lnp6[a]	-0.0153	0.0172	-0.8900	0.3860
z2[b]	0.5194	0.2157	2.4100	0.0280
z3[b]	-3.8236	1.2533	-3.0500	0.0070
z4[b]	8.0727	2.3780	3.3900	0.0030
z5[b]	-4.7619	1.3381	-3.5600	0.0020
ρ1	-0.2449			
AIC	-136.7911			
R-square	0.7257			
Durbin-Watson	1.82			
Obs	28			

[a] lnp1, lnp2, lnp3 lnp4 lnp5 lnp6 are the log price of frozen seafood, frozen Poultry, frozen beef, frozen pork, fresh meat, and frozen other.
[b] z2, z3, z4, and z5 are the second, third, fourth and fifth degree polynomials

The estimated own-price elasticity of demand for the frozen seafood was not significant in the model. Similar to the demand system the frozen poultry had a complimentary relationship with demand for frozen seafood. In this model the price of frozen pork, fresh meat and frozen other were not significant. All the polynomial inverse lag terms were significant at the ten percent level. The estimates of the polynomial terms of the information index were used to construct weights, w_i , mentioned in equation (4.1). The calculated weights indicate a percentage change in consumption in the respective week. The weekly weights, w_i's , are plotted against time in Figure 6. The plot in Figure 6 shows that the consumption response to food safety information increase rapidly in the next week after gulf oil spill was announced. As per expectation, the consumption of frozen seafood increased at the expense of fresh seafood consumption in response to news about Gulf oil spill event.

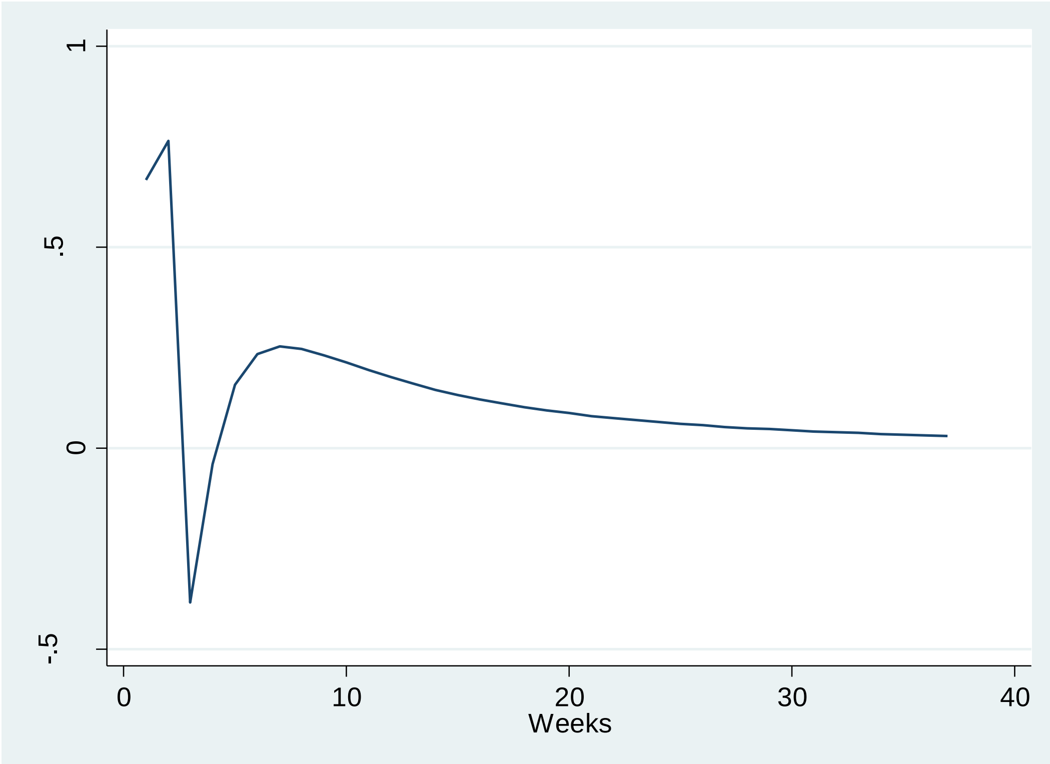

Figure 6: Weekly Changes in Frozen Seafood Purchases associated with Information Index

However, in subsequent weeks information shows a negative effect on the consumption of frozen seafood. After incorporating sentiment indices in a demand system model, this study also incorporated the net sentiment index in the PIL model. The polynomial terms were created using a net sentiment index instead of the information index. For ease in comparison with elasticities from the demand system model, this model utilizes the log of quantity purchased per week per household as the dependent variable. This study uses a Prais-Winsten and Cochrane-Orcutt log-log regression model. After testing for several different combinations, with the use of Akaike Information Criterion (AIC), results from estimated demand equation for frozen seafood are presented in Table 38.

Table 38: Polynomial Inverse Lag Model for Frozen Seafood with Net Sentiment Index

Variable	Estimate	Std. Error	t-statistics	P-value
Constant	3.3644	1.2945	2.60	0.0190
lnp1[a]	0.3724	0.2321	1.60	0.1270
lnp2[a]	-0.6992	0.2024	-3.46	0.0030
lnp3[a]	-0.2972	0.2143	-1.39	0.1830
lnp4[a]	0.1093	0.2264	0.48	0.6350
lnp5[a]	0.2509	0.5072	0.49	0.6270
lnp6[a]	0.0037	0.0201	0.19	0.8550
y2[b]	1.4517	0.5959	2.44	0.0260
y3[b]	-12.7022	5.6106	-2.26	0.0370
y4[b]	31.0775	15.5256	2.00	0.0620
y5[b]	-19.8399	10.5738	-1.88	0.0780
ρ1	-0.2631			
AIC	-125.9532			
R-square	0.6303			
Durbin-Watson	1.90			
Obs	28			

[a]lnp1, lnp2, lnp3 lnp4 lnp5 lnp6 are the log price of frozen seafood, frozen Poultry, frozen beef, frozen pork, fresh meat, and frozen other.
[b]y2, y3, y4, and y5 are the second, third, fourth and fifth degree polynomials of net sentiment index

The estimated own-price elasticity of demand for the frozen seafood was not significant in the model. However, the elasticity estimate for frozen poultry was significant and indicated a complimentary relationship with frozen seafood. All the polynomial inverse lag terms were significant at the ten percent level. The estimates for polynomial terms were used to calculate weights to indicate the percentage change in consumption in the respective week. The weekly weights, w_i's, are plotted against time in Figure 7. The plot in Figure 7 shows a sharp increase in the consumption of frozen seafood after the announcement of the Gulf oil spill event. However the change in consumption became negative in the next week and after a few more weeks had passed, the change was again positive.

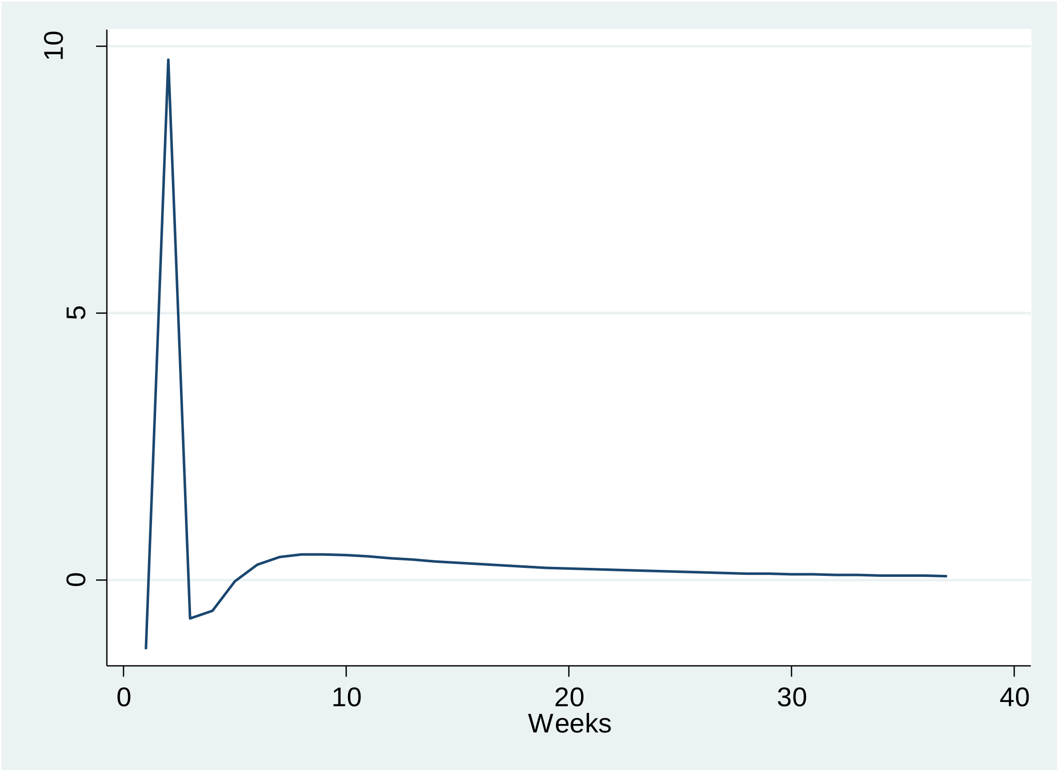

Figure 7: Weekly Decline in Peanut Butter Purchases associated with Net Sentiment Index

Results from Figure 7 plotting the change in average quantity consumed per week per household in response to the net sentiment index differs from Figure 6 in two ways. First, the net sentiment index shows a much larger increase in purchase in the second week after the event is announced. The plot from Figure 6 shows a 0.7 percent increase in consumption in the second week, while Figure 7 shows a 9.7 percent increase in consumption in the same week. Second, the percent increase in consumption associated net sentiment index starting four weeks after the Gulf oil spill event stays higher than consumption associated with information index in the subsequent weeks.

CHAPTER 5. SUMMARY AND CONCLUSION

The major focus of this study was to identify the linkage between information and consumer behavior and the creation of a new media index as a means of identifying the impact on the said linkage as it related to the tone of news stories. Past studies have relied on using the number of media stories relating to a particular incident, however this study tests a new approach that sought to analyze the effect of information by incorporating the sentiment indices created by analyzing each news story for the tone of the news story. The results from the sentiment indices were compared to the results from the information index. This study investigates three cases, where each case presents a unique scenario. The following section summarizes results and presents conclusions from each case studied.

5.1 PCA Peanut Butter Recall

The PCA peanut butter paste recall offers a peculiar situation to investigate. In early 2009, the FDA announced a recall of products which used peanut butter paste supplied by the PCA. However, earlier studies have found that consumption of major peanut butter brands suffered due to PCA's recall. The study utilizes weekly scanner data for the years 2008, 2009, and 2010 to estimate the demand for selected spreads including peanut butter using the Barten's Synthetic Model (BSM). The compensated, uncompensated own-price, cross-price elasticity and expenditure elasticity matrices were calculated for the BSM model. The compensated, uncompensated own-price, cross-price elasticity and expenditure elasticity matrices were also calculated for the differential versions of four specific demand systems viz. Rotterdam, CBS, AIDS and NBR. Neither the net sentiment index nor the information index registered an effect on demand for products studied, but negative sentiment index had a positive effect on the demand for jelly.

This study also tested structural changes in demand by comparing demand elasticities from pre-event period to post-event period. This study found that own-price elasticity for peanut butter changed significantly in the post-event period where consumers became more price sensitive to changes in the price of peanut butter. In the post-event period expenditure elasticity increased for jelly and jam while it decreased for the preserves significantly. This indicates that in the post-event period, consumers were willing to spend a larger budget share on the consumption of jelly and jam as compared to the pre-event period. In the post-event period, peanut butter had a significant substitution effect with jelly, jam and preserves. In the post-event period, the information index did not register an effect on demand for products studied, but the net sentiment index and the negative sentiment index had a positive effect on the demand for jelly.

This study investigates a single equation approach to identify the size and length of the information effect on the demand for peanut butter. It also incorporates a Polynomial Inverse lag (PIL) structure developed by Mitchell and Speaker (1986) to identify the effect that PCA peanut butter recall information had on the consumption of the peanut butter brands available on store shelves. The use of the PIL structure allows us to identify the size of the information effect on demand along with the length of the effect. The estimates from the polynomial terms were used to calculate the weights, which identify the effect of information on the consumption of peanut butter. This study utilizes peanut butter quantity and price data from the second week of January 2009 to the third week of December 2010. The results for the weights calculated from the model show that the effect of information peaked five weeks after the recall was announced. Six weeks after reaching the peak, the effect of information was halved. A PIL model using net sentiment index as independent variable was also analyzed. The results from the net sentiment index predicted a faster recovery in the demand for peanut butter.

The study presents two major findings. First, the food recall information affected the peanut butter consumption even though none of the brands were involved in the recall. This result is in accordance with the expectation that consumers will react adversely to the negative information. Secondly, the effect of the net sentiment index shows a larger decline, but faster recovery as compared to the information index.

5.2 Cookie Dough Recall

The second case attempts to identify the effect of the 2009 cookie dough recall on the refrigerated cookie dough brands during the pre-event and the post-event periods. The study utilizes weekly scanner data for the years 2008, 2009 and 2010 to estimate the demand for refrigerated cookie dough brands using the Barten's Synthetic Model for the pre-event (from 1^{st} January, 2008 to 19^{th} June 2009) and the post-event periods (from 19^{th} August, 2009 to 31^{st} December, 2010). The compensated, uncompensated own-price, cross-price elasticity and expenditure elasticity matrices were also calculated for the differential versions of four specific demand systems viz. Rotterdam, CBS, AIDS and NBR. The results support demand theory assertions and are similar to the results found in the literature.

The own-price and the cross-price relationships among the cookie dough brands changed from the pre-event to post-event period. Elasticity estimates suggest that the recall did contribute to structural change in cookie dough demand. This argument was supported by statistical tests conducted to identify the significant changes in the elasticity estimates between two time periods. The findings show that the substitution effect between Brand1 and Brand2 and between Brand1 and Store brand decreased from the pre-event to the post-event period. On the other hand, the substitution effect became stronger between Brand2 and Store brand in the post-event period. The findings suggest that Brand1 did suffer a reduction in demand after putting the product back on the shelves after eight weeks of recall. The expenditure elasticity for Brand1 also suffered in the post-event period, whereas it rose slightly for rest of the competing brands. This suggests that after the recall Brand1 lost part of its expenditure share to the rival brands.

The result for the BSM model confirms the effect of information on the demand of cookie dough brands for the period after the recall. Net sentiment index, information index and negative sentiment index had a significant negative effect on the demand for Brand1. The consumption of Brand1 which was implicated in the 2009 refrigerated cookie dough recall, suffered with the rise in information about the recall. The findings from this study are particularly interesting because of the use of sentiment index. The results from net sentiment index also showed that Other brands benefitted from the negative publicity that Brand1 received during and after the recall.

The study also compared the estimates from specific functional forms of demand systems against the synthetic model. The synthetic model rejected all the specific functional forms in the post-event period; however in the pre-event period synthetic model was not able to reject CBS and AIDS model as separate demand system. The estimation of the demand for cookie dough products in the pre-event and post-event period using a synthetic model provides a flexible functional form which is not restricted by specific forms of Engel curves on which the four nested demand systems are built. The results confirm Matsuda’s (2005) argument of estimating a synthetic model first and then testing the adequacy of nested models. Failure to do so might lead to biased elasticity estimates.

After identifying the long-term effect of information on average weekly consumption of Brand1 cookie dough in the demand system, this study investigated a single equation approach in order to identify the weekly changes in the size and length of the information effect had on the demand for Brand1 cookie dough. However, this study was unable find a significant effect on the average consumption of Brand1. After the announcement of the recall, Brand1 was taken off store shelves and only returned to shelves on August 18th, 2009. The parent company for Brand1 cookie dough responded quickly and handled the recall efficiently, which limited the media coverage for Brand1 cookie dough recall as seen Figure 5.

The investigation of refrigerated cookie dough recall displays some important outcomes related to the information index and sentiment indices. First, magnitude of the effect for sentiment indices was higher as compared to information index. Second, results from separate positive and negative sentiment indices were commensurate with results from net sentiment index and information index. The results reinforce the argument for the use of separate indices for positive and negative news.

5.3 Gulf Oil Spill Event

This case utilizes weekly scanner data for the years 2008, 2009 and 2010 to estimate the demand for meat products and frozen seafood subcategories using the Barten's Synthetic Model (BSM). For frozen seafood, the polynomial inverse lag model was also used to estimate the size and length of information effect had on demand. The compensated, uncompensated own-price, cross-price elasticity and expenditure elasticity matrices were calculated for the BSM model of meat products. The results support the tenants of demand theory and are similar to the results found in the literature. This study did not find frozen meat products to be responsive to the food recall information, except for the demand of frozen poultry products. The demand for frozen poultry appears to be responsive to the net sentiment index. The results found in this study are consistent with findings of Piggott and Marsh (2003), Marsh *et al.* (2004) and Kinnucan *et al.* (1997) where they have found poultry to be more responsive to both food safety information and health information. To our knowledge, this is the first study to incorporate a sentiment index identifying the tone of the news articles about the food recalls on the demand of meat products. Positive sentiment index also had a positive effect on the demand for frozen poultry, while negative sentiment index had a negative effect on the demand of fresh meat products. The results from separate media indices are acceptable considering fresh meat products are more susceptible to food safety incidents.

Structural changes in demand were also tested for by comparing demand elasticities from the pre-event period to the post-event period. However, this study was unable find significant changes in the demand elasticities for meat products between these two periods. In the post event period, neither the net sentiment index nor the information index had any noticeable effect on the demand for the products studied. The negative sentiment index recorded a positive effect on the demand for frozen seafood in the post-event period.

The polynomial inverse lag (PIL) model with net sentiment index and information index were analyzed and results were compared. The results from PIL model showed that Gulf oil spill incident had a transitory effect on the consumption of frozen seafood. The consumption of frozen seafood after the announcement of the Gulf oil spill event increased sharply for few weeks, however it rapidly returned to normal levels. Results from the net sentiment index predicted that demand for frozen seafood mostly benefitted from the Gulf oil spill event and the change in demand was positive for the majority of the study's duration.

5.4 Implications and Future Research

The results from the cases studied present several important implications. The food recall information not only has a negative effect on the consumption of product involved, but it also has a spillover effect on the substitutes of the product involved. The involvement of a brand increases the demand for substitutes. The tone of the information does play a vital role in affecting the demand for a product during and after the recall. Positive information helps to restrain losses, even though the effect might be small. Previous studies argue that any information only heightens consumer awareness, thus, separating positive and negative news is not useful. This argument can be dismissed by the results gleaned from the positive and negative sentiment indices in this study. The results from separate sentiment indices support the first part of argument that positive and negative information heightens consumer awareness, but the results also show that consumers respond differently to positive and negative news. Therefore, aggregating positive and negative news coverage related to a particular event may lead to biased results when trying to identify consumers' response to media coverage. Steps from the government and manufacturers to send positive messages to consumers about the product will help to reduce losses. Although, it is also important for the manufacturers to realize that sometimes information presented to consumers might be ambiguous and hurt a product that has not been involved in the food recall. Additionally, this study confirms these shocks from the food safety events to be transitory and the demand returns to normal level in a short time period.

Furthermore, the study brings important contributions to the existing literature. To our knowledge this is the first study which utilizes a natural word processing algorithm to identify the sentiment of the news story related to food safety incident and give a sentiment score to the story. This technique differs from previous studies which either utilized only the number of stories or gave a score to the article based on the subjective reading. The comparison between the media index created by using number of news stories and sentiment index reveal that sentiment index exhibits a stronger effect on the demand for the products tested. The positive and negative sentiment indices exhibited significant effect on the demand when net sentiment index and information index failed to find a significant effect. The results from sentiment indices show that it can be used as a feasible alternative to the currently used media indices.

The data constraints in this study barred us from identifying the effect of advertising campaigns steered by manufacturers and the government during and after the food safety event. Future research aims to test the effect of advertisement on the demand for a product after it has been implicated in a food safety event.

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APPENDIX A: PCA PEANUT BUTTER RECALL

Table A.1: Test of Nested models for Spreads using Information Index

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	10.54	0.0051
CBS	λ=1, μ=0	6.29	0.0431
AIDS	λ=1, μ=1	4.95	0.0842
NBR	λ=0, μ=1	9.11	0.0105

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table A.2: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads with Information Index

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.5717***	0.8623***	0.0032
Jelly	-0.6461***	0.7734***	0.0071
Marmalade	-0.6950***	1.6303***	0.0065
Preserve	-0.5310***	0.7526***	-0.0066
Jam	-0.6826***	0.9956***	-0.0085

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.3: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.3551***	0.0880***	0.0423	0.0786**	0.1422***
Jelly	0.1517***	-0.5333***	0.1169***	0.1440***	0.1217***
Marmalade	0.0560	0.0897***	-0.3853***	0.1072***	0.1306***
Preserve	0.0926**	0.0984***	0.0955***	-0.3705***	0.0859***
Jam	0.1789***	0.0889***	0.1242***	0.0917***	-0.4838***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.4: Test of Nested models for Spreads using Positive and Negative Sentiment Index

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	10.86	0.0044
CBS	λ=1, μ=0	6.72	0.0348
AIDS	λ=1, μ=1	4.91	0.0860
NBR	λ=0, μ=1	8.98	0.0112

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table A.5: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads with Positive and Negative Sentiment Index

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.5792***	0.8775***	0.0564	-0.3380
Jelly	-0.6507***	0.7947***	0.2146*	0.3092
Marmalade	-0.6821***	1.5940***	-0.2154	0.2602
Preserve	-0.5230***	0.7422***	-0.0370	0.1245
Jam	-0.6888***	1.0145***	0.0167	-0.1856

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.6: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Index

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.3544***	0.0894***	0.0459	0.0644*	0.1496***
Jelly	0.1540***	-0.5344***	0.1178***	0.1471***	0.1163***
Marmalade	0.0607	0.0905***	-0.3780***	0.1001***	0.1249***
Preserve	0.0758*	0.1006***	0.0891***	-0.3478***	0.0862***
Jam	0.1883***	0.0849***	0.1188***	0.0921***	-0.4841***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level

Table A.7: Test of Nested models for Spreads using Net Sentiment Index for Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	$\lambda=0, \mu=0$	15.43	0.0004
CBS	$\lambda=1, \mu=0$	12.66	0.0018
AIDS	$\lambda=1, \mu=1$	10.91	0.0043
NBR	$\lambda=0, \mu=1$	13.65	0.0011

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table A.8: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads with Net Sentiment Index for Pre-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Peanut Butter	-0.448***	0.892***	-0.352
Jelly	-0.631***	0.556***	-0.113
Marmalade	-0.676***	1.524***	0.188
Preserve	-0.790***	1.147***	0.157
Jam	-0.720***	0.806***	0.174

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.9: Compensated Own-Price and Cross-Price Elasticity for Spreads with Net Sentiment Index for Pre-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.2234***	0.0218	0.0418	-0.0367	0.1805***
Jelly	0.0383	-0.5513***	0.1195	0.2687***	0.1507*
Marmalade	0.0546	0.0889	-0.3818***	0.2313***	-0.0243
Preserve	-0.0432	0.1799***	0.2082***	-0.5445***	0.2274
Jam	0.2293***	0.1090*	-0.0236	0.2458	-0.5606***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level

Table A.10: Test of Nested models for Spreads using Net Sentiment Index for Post-event period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	1.02	0.6019
CBS	λ=1, μ=0	0.3	0.859
AIDS	λ=1, μ=1	0.34	0.8451
NBR	λ=0, μ=1	0.98	0.6132

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table A.11: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities of Synthetic model for Spreads with Net Sentiment Index for Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Peanut Butter	-0.7226***	0.8452***	0.0556
Jelly	-0.6490***	0.9502***	0.2219**
Marmalade	-0.7186***	1.6730***	-0.1190
Preserve	-0.4237***	0.5616***	-0.1132
Jam	-0.6745***	1.0630***	-0.0001

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.12: Compensated Own-Price and Cross-Price Elasticity for Spreads with Net Sentiment Index for Synthetic Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5104***	0.1339***	0.0395	0.1822***	0.2585***
Jelly	0.2287***	-0.5093***	0.1156**	0.0481	0.1055**
Marmalade	0.0526	0.0902**	-0.4031***	0.0651	0.2055***
Preserve	0.2149***	0.0332	0.0576	-0.3041***	-0.0020
Jam	0.1976***	0.0773**	0.1932***	-0.0021	-0.4660***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.13: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Rotterdam Model with Net Sentiment Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Peanut Butter	-0.7227***	0.85***	0.05844
Jelly	-0.6525***	0.95611***	0.2323**
Marmalade	-0.7131***	1.66078***	-0.1305
Preserve	-0.4158***	0.55597***	-0.1173
Jam	-0.6686***	1.07008***	0.00374

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.14: Compensated Own-Price and Cross-Price Elasticity for Spreads with Net Sentiment Index for Rotterdam Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5094***	0.1365***	0.0380	0.1826***	0.1524***
Jelly	0.2330***	-0.5119***	0.1143**	0.0477	0.1169**
Marmalade	0.0506	0.0891**	-0.4000***	0.0636	0.1968***
Preserve	0.2152***	0.0329	0.0563	-0.2974***	-0.0070
Jam	0.1949***	0.0772**	0.1957***	-0.0070	-0.4540***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.15: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for CBS Model with Net Sentiment Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Peanut Butter	-0.7212***	0.8423***	0.0533
Jelly	-0.6497***	0.9540***	0.2242**
Marmalade	-0.7210***	1.6718***	-0.1173
Preserve	-0.4220***	0.5638***	-0.1135
Jam	-0.6729***	1.0626***	-0.0003

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.16: Compensated Own-Price and Cross-Price Elasticity for Spreads with Net Sentiment Index for CBS Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5098***	0.1343***	0.0397	0.1827***	0.1530***
Jelly	0.2294***	-0.5095***	0.1163**	0.0478	0.1160**
Marmalade	0.0529	0.0907**	-0.4057***	0.0638	0.1983***
Preserve	0.2154***	0.0330	0.0565	-0.3020***	-0.0029
Jam	0.1915***	0.0850**	0.1865***	-0.0031	-0.4599***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.17: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for AIDS Model with Net Sentiment Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Peanut Butter	-0.7239***	0.8481***	0.0580
Jelly	-0.6482***	0.9459***	0.2195**
Marmalade	-0.7159***	1.6742***	-0.1210
Preserve	-0.4254***	0.5593***	-0.1129
Jam	-0.6761***	0.9557***	0.0001

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.18: Compensated Own-Price and Cross-Price Elasticity for Spreads with Net Sentiment Index for AIDS Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5110***	0.1335***	0.0393	0.1817***	0.1566***
Jelly	0.2279***	-0.5092***	0.1149**	0.0486	0.1179**
Marmalade	0.0523	0.0896**	-0.4003***	0.0664	0.1921***
Preserve	0.2142***	0.0335	0.0588	-0.3063***	-0.0002
Jam	0.2004***	0.0776**	0.1905***	0.0017	-0.4628***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.19: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for NBR Model with Net Sentiment Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Peanut Butter	-0.7254***	0.8554***	0.063
Jelly	-0.6509***	0.9481***	0.2277**
Marmalade	-0.7082***	1.6635***	-0.1341
Preserve	-0.4193***	0.5514***	-0.1167
Jam	-0.6719***	1.0715***	0.0042

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.20: Compensated Own-Price and Cross-Price Elasticity for Spreads with Net Sentiment Index for NBR Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5107***	0.1356***	0.0375	0.1817***	0.1559***
Jelly	0.2315***	-0.5116***	0.1129**	0.0483	0.1189**
Marmalade	0.0499	0.0880**	-0.3946***	0.0661	0.1906***
Preserve	0.2142***	0.0334	0.0586	-0.3019***	-0.0043
Jam	0.1997***	0.0787**	0.1896***	-0.0029	-0.4570***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.21: Test of Nested models for Spreads using Information Index in Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	9.11	0.0105
CBS	λ=1, μ=0	6.94	0.0311
AIDS	λ=1, μ=1	7.94	0.0189
NBR	λ=0, μ=1	10.05	0.0066

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table A.22: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Synthetic Model with Information Index in Pre-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.6200***	1.0367***	0.0043
Jelly	-0.6624***	0.5344***	-0.0071
Marmalade	-0.6116***	1.4658***	0.0037
Preserve	-0.6096***	0.9873***	-0.0044
Jam	-0.6705***	0.8507***	0.0000

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.23: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index for Synthetic Model in Pre-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.3591***	0.1364***	0.1106*	-0.0735	0.1856***
Jelly	0.2394***	-0.5858***	0.0391	0.1750**	0.1322**
Marmalade	0.1444*	0.0291	-0.3290**	0.1942***	-0.0387
Preserve	-0.0864	0.1172**	0.1748***	-0.3981**	0.1925
Jam	0.2358***	0.0957**	-0.0376	0.2081	-0.5020***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.24: Test of Nested models for Spreads using Information Index in Post-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	1.07	0.5867
CBS	λ=1, μ=0	0.29	0.8666
AIDS	λ=1, μ=1	0.35	0.8396
NBR	λ=0, μ=1	1.06	0.589

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table A.25: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Synthetic Model with Information Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.7201***	0.8140***	0.0002
Jelly	-0.6376***	0.8942***	0.0078
Marmalade	-0.7307***	1.7165***	-0.0021
Preserve	-0.4404***	0.6000***	-0.0069
Jam	-0.6723***	1.0614***	0.0033

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.26: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index for Synthetic Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5157***	0.1294***	0.0427	0.1907***	0.1529***
Jelly	0.2209***	-0.5062***	0.1241***	0.0485	0.1126**
Marmalade	0.0569	0.0968***	-0.4071***	0.0588	0.1947***
Preserve	0.2248***	0.0335	0.0520	-0.3126***	0.0023
Jam	0.1914***	0.0825**	0.1830***	0.0024	-0.4595***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.27: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Rotterdam Model with Information Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.7201***	0.8189***	0.0005
Jelly	-0.6407***	0.8976***	0.0084
Marmalade	-0.7260***	1.7075***	-0.0024
Preserve	-0.4313***	0.5942***	-0.0075
Jam	-0.6660***	1.0674***	0.0035

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.28: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index for Rotterdam Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5146***	0.1321***	0.0413	0.1907***	0.1506***
Jelly	0.2255***	-0.5087***	0.1230***	0.0476	0.1126**
Marmalade	0.0550	0.0959***	-0.4040***	0.0570	0.1962***
Preserve	0.2248***	0.0328	0.0504	-0.3048***	-0.0032
Jam	0.1884***	0.0825**	0.1844***	-0.0034	-0.4520***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.29: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for CBS Model with Information Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.7189***	0.8122***	0.0001
Jelly	-0.6383***	0.8975***	0.0081
Marmalade	-0.7324***	1.7146***	-0.0021
Preserve	-0.4383***	0.6017***	-0.0069
Jam	-0.6706***	1.0612***	0.0033

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.30: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index for CBS Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5150***	0.1299***	0.0427	0.1910***	0.1513***
Jelly	0.2219***	-0.5064***	0.1247***	0.0481	0.1116**
Marmalade	0.0568	0.0972***	-0.4091***	0.0576	0.1975***
Preserve	0.2252***	0.0332	0.0510	-0.3102***	0.0007
Jam	0.1894***	0.0818**	0.1857***	0.0008	-0.4578***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.31: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for AIDS Model with Information Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.7441***	0.9328***	0.0040
Jelly	-0.6655***	0.8592***	0.0088
Marmalade	-0.7178***	1.7300***	-0.0041
Preserve	-0.3896***	0.5665***	-0.0077
Jam	-0.6605***	0.9612***	0.0005

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.32: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index for AIDS Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5100***	0.1494***	0.0359	0.1659***	0.1588***
Jelly	0.2550***	-0.5392***	0.1337***	0.0503	0.1001**
Marmalade	0.0478	0.1042***	-0.3916***	0.0377	0.2019***
Preserve	0.1955***	0.0347	0.0334	-0.2690***	0.0054
Jam	0.1988***	0.0734**	0.1898***	0.0057	-0.4677***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.33: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for NBR Model with Information Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Information Elasticity
Peanut Butter	-0.7227***	0.8232***	0.0007
Jelly	-0.6395***	0.8905***	0.0079
Marmalade	-0.7216***	1.7109***	-0.0023
Preserve	-0.4348***	0.5896***	-0.0075
Jam	-0.6692***	1.0689***	0.0035

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.34: Compensated Own-Price and Cross-Price Elasticity for Spreads with Information Index for NBR Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5161***	0.1311***	0.0411	0.1899***	0.1539***
Jelly	0.2240***	-0.5086***	0.1216***	0.0482	0.1149**
Marmalade	0.0548	0.0948***	-0.3990***	0.0594	0.1900***
Preserve	0.2239***	0.0333	0.0526	-0.3093***	-0.0005
Jam	0.1926***	0.0842**	0.1786***	-0.0006	-0.4549***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.35: Test of Nested models for Spreads using Positive and Negative Sentiment Indices in Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	$\lambda=0, \mu=0$	11.43	0.0033
CBS	$\lambda=1, \mu=0$	8.86	0.0119
AIDS	$\lambda=1, \mu=1$	9.4	0.0091
NBR	$\lambda=0, \mu=1$	11.9	0.0026

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table A.36: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Synthetic Model with Positive and Negative Sentiment Indices in Pre-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.6328***	1.05335***	-0.0303	-0.1272
Jelly	-0.6103***	0.47397***	-0.1737	1.73943***
Marmalade	-0.628***	1.53706***	0.2458	-1.6882*
Preserve	-0.5593***	0.94707***	-0.0959	0.41082
Jam	-0.6656***	0.84755***	0.01439	0.10129

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.37: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Indices for Synthetic Model in Pre-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.3677***	0.1381***	0.0975	-0.0878	0.2199***
Jelly	0.2423***	-0.5423***	0.0382	0.1718**	0.0900
Marmalade	0.1274	0.0284	-0.3317***	0.2007***	-0.0248
Preserve	-0.1032	0.1150**	0.1807***	-0.3565***	0.1640
Jam	0.2794***	0.0651	-0.0241	0.1773	-0.4977***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.38: Test of Nested models for Spreads using Positive and Negative Sentiment Indices in Post-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	0.88	0.6425
CBS	λ=1, μ=0	0.3	0.862
AIDS	λ=1, μ=1	0.34	0.8437
NBR	λ=0, μ=1	0.86	0.6507

Table value of χ2 for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table A.39: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Synthetic Model with Positive and Negative Sentiment Indices in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.7232***	0.84445***	0.05551	-0.0741
Jelly	-0.6500***	0.9497***	0.2315**	-0.2352
Marmalade	-0.7197***	1.6566***	-0.1202	0.1316
Preserve	-0.4263***	0.5642***	-0.1118	0.0390
Jam	-0.6751***	1.0662***	-0.0003	0.0941

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.40: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Indices for Synthetic Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5107***	0.1319***	0.0415	0.1835***	0.1539***
Jelly	0.2315***	-0.5138***	0.1181**	0.0474	0.1168**
Marmalade	0.0542	0.0878**	-0.4004***	0.0670	0.1914***
Preserve	0.2156***	0.0318	0.0603	-0.3055***	-0.0022
Jam	0.1955***	0.0845**	0.1863***	-0.0023	-0.4639***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.41: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for Rotterdam Model with Positive and Negative Sentiment Indices in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.7219***	0.8465***	0.0574	-0.0614
Jelly	-0.6655***	0.9800***	0.2416**	-0.2333
Marmalade	-0.7044***	1.6249***	-0.1302	0.1325
Preserve	-0.4162***	0.5535***	-0.1140	0.0028
Jam	-0.6756***	1.0841***	0.0023	0.1150

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.42: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Indices for Rotterdam Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5089***	0.1359***	0.0378	0.1827***	0.1524***
Jelly	0.2386***	-0.5250***	0.1171**	0.0487	0.1205**
Marmalade	0.0493	0.0871**	-0.3912***	0.0628	0.1919***
Preserve	0.2147***	0.0326	0.0565	-0.2977***	-0.0062
Jam	0.1936***	0.0872**	0.1867***	-0.0067	-0.4609***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.43: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for CBS Model with Positive and Negative Sentiment Indices in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.7213***	0.8413***	0.0530	-0.0766
Jelly	-0.6590***	0.9521***	0.2331**	-0.2288
Marmalade	-0.7162***	1.6575***	-0.1174	0.1235
Preserve	-0.4235***	0.5673***	-0.1119	0.0423
Jam	-0.6773***	1.0643***	-0.0008	0.0970

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.44: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Indices for CBS Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5096***	0.1338***	0.0395	0.1831***	0.1532***
Jelly	0.2348***	-0.5225***	0.1192**	0.0491	0.1194**
Marmalade	0.0516	0.0887**	-0.3967***	0.0629	0.1935***
Preserve	0.2152***	0.0329	0.0566	-0.3020***	-0.0026
Jam	0.1946***	0.0864**	0.1883***	-0.0028	-0.4665***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.45: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for AIDS Model with Positive and Negative Sentiment Indices in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.7250***	0.8470***	0.0575	-0.0729
Jelly	-0.6395***	0.9433***	0.2287**	-0.2414
Marmalade	-0.7249***	1.6598***	-0.1216	0.1389
Preserve	-0.4302***	0.5629***	-0.1112	0.0403
Jam	-0.6731***	1.0659***	0.0000	0.0886

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.46: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Indices for AIDS Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5119***	0.1295***	0.0438	0.1838***	0.1548***
Jelly	0.2273***	-0.5043***	0.1172**	0.0459	0.1139**
Marmalade	0.0572	0.0871**	-0.4050***	0.0713	0.1893***
Preserve	0.2160***	0.0308	0.0642	-0.3097***	-0.0012
Jam	0.1966***	0.0824**	0.1842***	-0.0013	-0.4619***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.47: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities for Spreads for NBR Model with Positive and Negative Sentiment Indices in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Peanut Butter	-0.7256***	0.8519***	0.0617	-0.0574
Jelly	-0.6459***	0.9714***	0.2373**	-0.2460
Marmalade	-0.7131***	1.6274***	-0.1343	0.1476
Preserve	-0.4231***	0.5491***	-0.1134	0.0006
Jam	-0.6715***	1.0858***	0.0031	0.1067

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.48: Compensated Own-Price and Cross-Price Elasticity for Spreads with Positive and Negative Sentiment Indices for NBR Model in Post-event Period

	Peanut Butter	Jelly	Marmalade	Preserve	Jam
Peanut Butter	-0.5112***	0.1316***	0.0420	0.1836***	0.1540***
Jelly	0.2310***	-0.5066***	0.1150**	0.0454	0.1151**
Marmalade	0.0549	0.0856**	-0.3995***	0.0712	0.1878***
Preserve	0.2157***	0.0304	0.0641	-0.3055***	-0.0048
Jam	0.1956***	0.0833**	0.1827***	-0.0052	-0.4564***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, All elasticities are calculated at the sample mean

Table A.49: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Net Sentiment Index

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.7409	0.3061	-2.42	0.0167
b2	-0.4413	0.1782	-2.48	0.0144
b3	-0.4346	0.2336	-1.86	0.0648
b4	-0.6766	0.2603	-2.60	0.0103
b5[a]	-0.5660	0.2467	-2.29	0.0232
g11	-0.0689	0.1585	-0.43	0.6643
g12	0.0237	0.0315	0.75	0.4527
g13	0.0061	0.0409	0.15	0.8809
g14	0.0088	0.0464	0.19	0.8491
g15[a]	0.0275	0.0423	0.65	0.5176
g22	-0.0541	0.1054	-0.51	0.6083
g23	0.0093	0.0241	0.39	0.6984
g24	0.0088	0.0273	0.32	0.7485
g25[a]	0.0113	0.0253	0.45	0.6568
g33	-0.0421	0.1300	-0.32	0.7464
g34	0.0111	0.0343	0.32	0.7468
g35[a]	0.0137	0.0331	0.41	0.6809
g44	-0.0380	0.1414	-0.27	0.7883
g55	-0.0603	0.1344	-0.45	0.6543
z1	0.0075	0.0226	0.33	0.7404
z2	0.0290	0.0167	1.74	0.0841
z3	-0.0512	0.0314	-1.63	0.1055
z4	-0.0014	0.0209	-0.07	0.9462
z5[a]	0.0156	0.0234	0.67	0.5057
y1	0.0302	0.0219	1.38	0.1705
y2	0.0028	0.0163	0.17	0.8655
y3	0.0454	0.0307	1.48	0.1409
y4	-0.0389	0.0205	-1.90	0.0595
y5[a]	-0.0403	0.0229	-1.75	0.0814
x1	-0.0109	0.0231	-0.47	0.6373
x2	-0.0183	0.0172	-1.06	0.2893
x3	-0.0083	0.0324	-0.26	0.7987
x4	0.0119	0.0216	0.55	0.5837
x5[a]	0.0270	0.0243	1.11	0.2680
ρ1	-0.4493	0.0620	-7.25	<.0001
ρ2	-0.4713	0.0661	-7.13	<.0001
ρ3	-0.5301	0.0540	-9.82	<.0001
ρ4	-0.5135	0.0611	-8.41	<.0001
λ	3.8729	1.2196	3.18	0.0018
μ	0.1977	0.8432	0.23	0.8149
$R^2$1	0.5172			
$R^2$2	0.6931			
$R^2$3	0.6593			

$R^2$4	0.5054
DW1	2.2428
DW2	2.2845
DW3	2.4570
DW4	2.3389

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of sentiment index.

Table A.50: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Information Index

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.7381	0.3161	-2.34	0.0209
b2	-0.4413	0.184	-2.40	0.0176
b3	-0.4121	0.2408	-1.71	0.0891
b4	-0.6501	0.2684	-2.42	0.0167
b5[a]	-0.5399	0.2545	-2.12	0.0356
g11	0.0780	0.1576	0.50	0.6213
g12	-0.0105	0.0312	-0.33	0.7381
g13	-0.0318	0.0406	-0.78	0.4352
g14	-0.0279	0.0463	-0.60	0.5473
g15[a]	-0.0097	0.0419	-0.23	0.8174
g22	0.0330	0.1055	0.31	0.7552
g23	-0.0076	0.0242	-0.31	0.7549
g24	-0.0067	0.0275	-0.24	0.8091
g25[a]	-0.0086	0.0253	-0.34	0.7341
g33	0.0636	0.1301	0.49	0.6256
g34	-0.0157	0.0344	-0.45	0.6499
g35[a]	-0.0095	0.0331	-0.29	0.7741
g44	0.0702	0.1419	0.49	0.6217
g55[a]	0.0481	0.1339	0.36	0.7202
z1	0.0004	0.0012	0.32	0.7522
y1	0.0007	0.0012	0.57	0.5708
z2	0.0009	0.0009	1.05	0.2959
y2	0.0009	0.0009	1.01	0.3160
z3	-0.0019	0.0016	-1.17	0.2427

Table A.50: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Information Index

Parameter	Estimate	Std. Error	t-value	P-value
y3	0.0016	0.0016	0.98	0.3281
z4	-0.0007	0.0011	-0.61	0.5461
y4	-0.0013	0.0011	-1.16	0.2469
z5 [a]	0.0011	0.0012	0.94	0.3489
y5 [a]	-0.0019	0.0012	-1.54	0.1250
λ	3.7999	1.2588	3.02	0.0030
μ	0.8889	0.8443	1.05	0.2942
ρ1	-0.4144	0.0627	-6.61	<.0001
ρ2	-0.4414	0.0661	-6.68	<.0001
ρ3	-0.5132	0.0533	-9.63	<.0001
ρ4	-0.5019	0.0606	-8.28	<.0001
$R^2$1	0.4669			
$R^2$2	0.673			
$R^2$3	0.656			
$R^2$4	0.501			
DW1	2.15			
DW2	2.17			
DW3	2.51			
DW4	2.39			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z and y are the coefficients for no lag and first lag of sentiment index.

Table A.51: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Separate Indices

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.7307	0.3212	-2.27	0.0244
b2	-0.4361	0.1868	-2.33	0.0209
b3	-0.4163	0.2442	-1.70	0.0905
b4	-0.6492	0.2724	-2.38	0.0184
b5 [a]	-0.5308	0.2585	-2.05	0.0418
g11	0.0973	0.1587	0.61	0.5408
g12	-0.0147	0.0314	-0.47	0.6417
g13	-0.0367	0.0409	-0.90	0.3714
g14	-0.0348	0.0466	-0.75	0.4560
g15 [a]	-0.0133	0.0422	-0.32	0.7527
g22	0.0461	0.1062	0.43	0.6649

Table A.51: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Separate Indices

Parameter	Estimate	Std. Error	t-value	P-value
g23	-0.0105	0.0243	-0.43	0.6668
g24	-0.0090	0.0277	-0.32	0.7466
g25 [a]	-0.0124	0.0255	-0.49	0.6279
g33	0.0813	0.1309	0.62	0.5358
g34	-0.0204	0.0347	-0.59	0.5576
g35 [a]	-0.0148	0.0333	-0.44	0.6581
g44	0.0894	0.1430	0.63	0.5327
g55 [a]	0.0657	0.1349	0.49	0.6272
z1	0.0142	0.0233	0.61	0.5437
z2	0.0313	0.0169	1.85	0.0657
z3	-0.0409	0.0306	-1.34	0.1839
z4	-0.0079	0.0209	-0.38	0.7063
z5	0.0043	0.0231	0.19	0.8516
v1	-0.0463	0.0738	-0.63	0.5320
v2	-0.0418	0.0534	-0.78	0.4354
v3	0.0783	0.0987	0.79	0.4287
v4	-0.0018	0.0673	-0.03	0.9793
v5 [a]	0.0167	0.0746	0.22	0.8229
s1	-0.0733	0.0679	-1.08	0.2818
s2	0.0512	0.0494	1.04	0.3015
s3	0.0345	0.0909	0.38	0.7044
s4	0.0269	0.0623	0.43	0.6661
s5 [a]	-0.0393	0.0692	-0.57	0.5708
λ	3.7856	1.2783	2.96	0.0036
μ	0.9964	0.8499	1.17	0.2430
ρ1	-0.4284	0.0627	-6.84	<.0001
ρ2	-0.4417	0.0663	-6.66	<.0001
ρ3	-0.5162	0.0541	-9.54	<.0001
ρ4	-0.5011	0.0611	-8.21	<.0001
$R^2$1	0.4712			
$R^2$2	0.6805			
$R^2$3	0.6552			
$R^2$4	0.4953			
DW1	2.15			
DW2	2.18			
DW3	2.51			
DW4	2.37			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z and y are the coefficients for no lag and first lag of negative sentiment index and v and s are the coefficients for no lag and first lag of positive sentiment index.

Table A.52: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Net Sentiment Index for Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-2.0438	0.6317	-3.24	0.0023
b2	-1.2126	0.3601	-3.37	0.0016
b3	-1.4436	0.4905	-2.94	0.0051
b4	-1.6846	0.5401	-3.12	0.0032
b5 [a]	-1.7015	0.5047	-3.37	0.0015
g11	0.3083	0.2646	1.17	0.2501
g12	-0.0643	0.0519	-1.24	0.2218
g13	-0.0834	0.0677	-1.23	0.2247
g14	-0.1136	0.0784	-1.45	0.1545
g15 [a]	-0.0617	0.0721	-0.86	0.3968
g22	0.1587	0.1758	0.90	0.3715
g23	-0.0364	0.0404	-0.90	0.3734
g24	-0.0209	0.0470	-0.44	0.6585
g25 [a]	-0.0394	0.0426	-0.92	0.3600
g33	0.2276	0.2185	1.04	0.3031
g34	-0.0353	0.0575	-0.61	0.5424
g35 [a]	-0.0867	0.0583	-1.49	0.1436
g44	0.2091	0.2395	0.87	0.3872
g55 [a]	0.2304	0.2305	1.00	0.3230
z1	-0.0314	0.0286	-1.10	0.2770
z2	-0.0218	0.0203	-1.07	0.2885
z3	0.0230	0.0457	0.50	0.6165
z4	0.0280	0.0239	1.17	0.2471
z5 [a]	0.0522	0.0760	0.69	0.4964
y1	-0.0806	0.0323	-2.50	0.0162
y2	-0.0130	0.0232	-0.56	0.5781
y3	0.0318	0.0487	0.65	0.5175
y4	0.0277	0.0282	0.98	0.3312
y5 [a]	0.0281	0.0326	0.86	0.3936
λ	9.0138	2.5194	3.58	0.0008
μ	1.9354	1.4284	1.36	0.1822
ρ1	-0.5694	0.0969	-5.87	<.0001
ρ2	-0.6063	0.1082	-5.60	<.0001
ρ3	-0.4531	0.0913	-4.96	<.0001
ρ4	-0.4073	0.1173	-3.47	0.0011
$R^2$1	0.5367			
$R^2$2	0.7430			
$R^2$3	0.6085			
$R^2$4	0.6597			
DW1	2.41			
DW2	2.10			
DW3	2.54			
DW4	2.46			

Table A.52: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Net Sentiment Index for Pre-event Period

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z and y are the coefficients for no lag and first lag of net sentiment index.

Table A.53: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0397	0.3080	-0.13	0.8977
b2	-0.0078	0.1807	-0.04	0.9656
b3	0.1263	0.2294	0.55	0.5833
b4	-0.0941	0.2593	-0.36	0.7176
b5 [a]	0.0719	0.2504	0.29	0.7747
g11	-0.0365	0.1666	-0.22	0.8269
g12	0.0156	0.0337	0.46	0.6435
g13	-0.0131	0.0427	-0.31	0.7592
g14	0.0197	0.0487	0.40	0.6868
g15 [a]	0.0140	0.0443	0.32	0.7532
g22	-0.0138	0.1112	-0.12	0.9016
g23	0.0035	0.0255	0.14	0.8914
g24	-0.0082	0.0288	-0.28	0.7768
g25 [a]	0.0005	0.0268	0.02	0.9858
g33	-0.0015	0.1367	-0.01	0.9914
g34	-0.0073	0.0361	-0.20	0.8403
g35 [a]	0.0195	0.0352	0.55	0.5821
g44	0.0169	0.1485	0.11	0.9097
g55 [a]	-0.0117	0.1412	-0.08	0.9340
z1	0.0140	0.0214	0.65	0.5149
z2	0.0326	0.0159	2.05	0.0427
z3	-0.0225	0.0249	-0.90	0.3699
z4	-0.0241	0.0180	-1.34	0.1831
z5 [a]	-0.0046	0.0195	-0.24	0.8141
λ	1.0033	1.2199	0.82	0.4128
μ	0.4871	0.8844	0.55	0.5831
ρ11	-0.5719	0.0826	-6.93	<.0001
ρ12	-0.3729	0.0815	-4.57	<.0001

Table A.53: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
ρ21	-0.5779	0.0877	-6.59	<.0001
ρ22	-0.2912	0.0870	-3.35	0.0012
ρ31	-0.7795	0.0761	-10.25	<.0001
ρ32	-0.3747	0.0761	-4.92	<.0001
ρ41	-0.7851	0.0806	-9.74	<.0001
ρ42	-0.3502	0.0811	-4.32	<.0001
$R^2$1	0.5146			
$R^2$2	0.6881			
$R^2$3	0.7206			
$R^2$4	0.5567			
DW1	2.16			
DW2	2.00			
DW3	2.21			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of net sentiment index.

Table A.54: Parameter Estimates of Rotterdam Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	0.2134	0.0245	8.71	<.0001
b2	0.1405	0.0186	7.56	<.0001
b3	0.3131	0.0277	11.29	<.0001
b4	0.1184	0.0223	5.31	<.0001
b5 [a]	0.1927	0.0226	8.54	<.0001
g11	-0.1279	0.0144	-8.90	<.0001
g12	0.0343	0.0082	4.16	<.0001
g13	0.0095	0.0084	1.13	0.2613
g14	0.0458	0.0104	4.42	<.0001
g15 [a]	0.0391	0.0088	4.44	<.0001
g22	-0.0753	0.0088	-8.51	<.0001
g23	0.0168	0.0065	2.59	0.0112
g24	0.0070	0.0081	0.87	0.3887
g25 [a]	0.0155	0.0069	2.25	0.0270

Table A.54: Parameter Estimates of Rotterdam Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
g33	-0.0754	0.0121	-6.22	<.0001
g34	0.0120	0.0082	1.46	0.1462
g35 [a]	0.0392	0.0083	4.71	<.0001
g44	-0.0633	0.0142	-4.45	<.0001
g55 [a]	-0.0924	0.0105	-8.84	<.0001
z1	0.0147	0.0213	0.69	0.4927
z2	0.0341	0.0157	2.17	0.0322
z3	-0.0246	0.0247	-0.99	0.3226
z4	-0.0250	0.0180	-1.38	0.1697
z5 [a]	-0.0043	0.0194	-0.22	0.8246
ρ11	-0.5788	0.0823	-7.04	<.0001
ρ12	-0.3751	0.0813	-4.61	<.0001
ρ21	-0.5827	0.0871	-6.69	<.0001
ρ22	-0.2919	0.0863	-3.38	0.0010
ρ31	-0.7767	0.0755	-10.29	<.0001
ρ32	-0.3707	0.0755	-4.91	<.0001
ρ41	-0.7832	0.0800	-9.79	<.0001
ρ42	-0.3595	0.0806	-4.46	<.0001
$R^2$1	0.5122			
$R^2$2	0.6898			
$R^2$3	0.7204			
$R^2$4	0.5507			
DW1	2.17			
DW2	2.01			
DW3	2.21			
DW4	2.12			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.55: Parameter Estimates of CBS Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0396	0.0245	-1.62	0.1089
b2	-0.0068	0.0186	-0.36	0.7172
b3	0.1267	0.0277	4.57	<.0001
b4	-0.0929	0.0222	-4.19	<.0001
b5 [a]	-0.0096	0.0226	-0.42	0.6718
g11	-0.1280	0.0144	-8.89	<.0001

Table A.55: Parameter Estimates of CBS Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

g12	0.0337	0.0082	4.10	<.0001
g13	0.0100	0.0084	1.19	0.2383
g14	0.0459	0.0103	4.44	<.0001
g15 [a]	0.0392	0.0088	4.45	<.0001
g22	-0.0749	0.0088	-8.47	<.0001
g23	0.0171	0.0065	2.63	0.0099
g24	0.0070	0.0081	0.87	0.3860
g25 [a]	0.0153	0.0069	2.21	0.0294
g33	-0.0765	0.0121	-6.30	<.0001
g34	0.0120	0.0082	1.48	0.1430
g35 [a]	0.0394	0.0084	4.72	<.0001
g44	-0.0643	0.0141	-4.55	<.0001
g55 [a]	-0.0934	0.0105	-8.92	<.0001
z1	0.0134	0.0213	0.63	0.5314
z2	0.0330	0.0157	2.09	0.0389
z3	-0.0221	0.0247	-0.89	0.3733
z4	-0.0242	0.0180	-1.34	0.1822
z5 [a]	-0.0052	0.0195	-0.27	0.7907
ρ11	-0.5704	0.0823	-6.93	<.0001
ρ12	-0.3740	0.0813	-4.60	<.0001
ρ21	-0.5794	0.0874	-6.63	<.0001
ρ22	-0.2918	0.0867	-3.37	0.0011
ρ31	-0.7794	0.0756	-10.31	<.0001
ρ32	-0.3734	0.0756	-4.94	<.0001
ρ41	-0.7826	0.0800	-9.78	<.0001
ρ42	-0.3523	0.0806	-4.37	<.0001
$R^2$1	0.5143			
$R^2$2	0.6892			
$R^2$3	0.7198			
$R^2$4	0.5545			
DW1	2.16			
DW2	2.01			
DW3	2.21			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.56: Parameter Estimates of AIDS Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0381	0.0244	-1.56	0.1220
b2	-0.0080	0.0187	-0.43	0.6711
b3	0.1271	0.0277	4.58	<.0001
b4	-0.0938	0.0220	-4.26	<.0001
b5 [a]	-0.0089	0.0227	-0.39	0.6957
g11	0.0597	0.0144	4.15	<.0001
g12	-0.0034	0.0083	-0.41	0.6813
g13	-0.0375	0.0084	-4.45	<.0001
g14	-0.0078	0.0103	-0.76	0.4493
g15 [a]	-0.0102	0.0088	-1.15	0.2512
g22	0.0505	0.0089	5.70	<.0001
g23	-0.0108	0.0065	-1.66	0.1001
g24	-0.0242	0.0081	-3.00	0.0034
g25 [a]	-0.0139	0.0069	-2.01	0.0472
g33	0.0775	0.0121	6.41	<.0001
g34	-0.0276	0.0081	-3.41	0.0009
g35 [a]	0.0004	0.0084	0.05	0.9622
g44	0.1024	0.0141	7.26	<.0001
g55 [a]	0.0660	0.0105	6.29	<.0001
z1	0.0145	0.0213	0.68	0.4957
z2	0.0323	0.0158	2.04	0.0441
z3	-0.0228	0.0247	-0.92	0.3578
z4	-0.0240	0.0179	-1.34	0.1819
z5 [a]	-0.0047	0.0195	-0.24	0.8105
ρ11	-0.5728	0.0824	-6.95	<.0001
ρ12	-0.3713	0.0812	-4.57	<.0001
ρ21	-0.5755	0.0875	-6.58	<.0001
ρ22	-0.2901	0.0868	-3.34	0.0012
ρ31	-0.7784	0.0756	-10.30	<.0001
ρ32	-0.3754	0.0757	-4.96	<.0001
ρ41	-0.7870	0.0804	-9.79	<.0001
ρ42	-0.3476	0.0811	-4.29	<.0001
$R^2$1	0.5144			
$R^2$2	0.6864			
$R^2$3	0.7207			
$R^2$4	0.5585			
DW1	2.15			
DW2	2.00			
DW3	2.22			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for

the respective equation, z is the coefficients for no lag of sentiment index.

Table A.57: Parameter Estimates of NBR Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	0.2147	0.0245	8.77	<.0001
b2	0.1394	0.0187	7.47	<.0001
b3	0.3136	0.0277	11.31	<.0001
b4	0.1174	0.0222	5.30	<.0001
b5 [a]	0.1934	0.0226	8.56	<.0001
g11	0.0598	0.0144	4.17	<.0001
g12	-0.0029	0.0083	-0.35	0.7292
g13	-0.0379	0.0085	-4.49	<.0001
g14	-0.0078	0.0103	-0.76	0.4503
g15 [a]	-0.0103	0.0088	-1.17	0.2445
g22	0.0502	0.0089	5.66	<.0001
g23	-0.0111	0.0065	-1.71	0.0909
g24	-0.0242	0.0081	-3.00	0.0035
g25 [a]	-0.0137	0.0069	-1.98	0.0504
g33	0.0786	0.0121	6.51	<.0001
g34	-0.0277	0.0081	-3.40	0.0010
g35 [a]	0.0002	0.0083	0.02	0.9803
g44	0.1033	0.0142	7.29	<.0001
g55 [a]	0.0671	0.0105	6.41	<.0001
z1	0.0158	0.0213	0.74	0.4596
z2	0.0335	0.0158	2.12	0.0366
z3	-0.0253	0.0247	-1.02	0.3087
z4	-0.0248	0.0179	-1.38	0.1693
z5 [a]	-0.0038	0.0194	-0.20	0.8448
ρ11	-0.5810	0.0823	-7.06	<.0001
ρ12	-0.3724	0.0812	-4.59	<.0001
ρ21	-0.5791	0.0872	-6.64	<.0001
ρ22	-0.2903	0.0865	-3.36	0.0011
ρ31	-0.7758	0.0755	-10.28	<.0001
ρ32	-0.3727	0.0756	-4.93	<.0001
ρ41	-0.7876	0.0804	-9.80	<.0001
ρ42	-0.3546	0.0811	-4.37	<.0001
$R^2$1	0.5118			
$R^2$2	0.6872			
$R^2$3	0.7214			
R^{24}	0.5550			
DW1	2.15			
DW2	2.00			
DW3	2.22			

Table A.57: Parameter Estimates of NBR Model for Peanut Butter Recall with Net Sentiment Index for Post-event Period

DW4	2.13

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.58: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0630	0.3106	-0.20	0.8398
b2	-0.0251	0.1820	-0.14	0.8907
b3	0.1229	0.2322	0.53	0.5979
b4	-0.0990	0.2615	-0.38	0.7059
b5 [a]	0.0849	0.2530	0.34	0.7380
g11	-0.0405	0.1681	-0.24	0.8100
g12	0.0150	0.0340	0.44	0.6593
g13	-0.0117	0.0430	-0.27	0.7868
g14	0.0226	0.0491	0.46	0.6467
g15 [a]	0.0150	0.0448	0.34	0.7377
g22	-0.0151	0.1122	-0.13	0.8933
g23	0.0051	0.0258	0.20	0.8424
g24	-0.0077	0.0290	-0.26	0.7917
g25 [a]	0.0004	0.0270	0.02	0.9870
g33	-0.0044	0.1378	-0.03	0.9747
g34	-0.0079	0.0364	-0.22	0.8284
g35 [a]	0.0204	0.0355	0.57	0.5673
g44	0.0127	0.1497	0.08	0.9325
g55 [a]	-0.0156	0.1426	-0.11	0.9132
z1	0.0000	0.0012	0.03	0.9731
z2	0.0012	0.0009	1.27	0.2056
z3	-0.0004	0.0014	-0.28	0.7819
z4	-0.0015	0.0010	-1.45	0.1513
z5 [a]	0.0001	0.0011	0.10	0.9213
λ	1.0648	1.2310	0.86	0.3892
μ	0.4730	0.8924	0.53	0.5973
ρ11	-0.5414	0.0834	-6.49	<.0001
ρ12	-0.3676	0.0812	-4.53	<.0001
ρ21	-0.5741	0.0869	-6.61	<.0001
ρ22	-0.3076	0.0864	-3.56	0.0006
ρ31	-0.7704	0.0759	-10.15	<.0001
ρ32	-0.3748	0.0755	-4.96	<.0001
ρ41	-0.7786	0.0808	-9.63	<.0001

Table A.58: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
ρ42	-0.3410	0.0806	-4.23	<.0001
$R^2$1	0.5112			
$R^2$2	0.6809			
$R^2$3	0.7175			
$R^2$4	0.5594			
DW1	2.16			
DW2	2.02			
DW3	2.22			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of information index.

Table A.59: Parameter Estimates of Rotterdam Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	0.2055	0.0239	8.59	<.0001
b2	0.1319	0.0182	7.25	<.0001
b3	0.3219	0.0269	11.95	<.0001
b4	0.1265	0.0209	6.06	<.0001
b5 [a]	0.1937	0.0217	8.93	<.0001
g11	-0.1292	0.0145	-8.93	<.0001
g12	0.0332	0.0083	4.02	0.0001
g13	0.0104	0.0084	1.24	0.2198
g14	0.0479	0.0103	4.66	<.0001
g15 [a]	0.0388	0.0088	4.40	<.0001
g22	-0.0748	0.0090	-8.33	<.0001
g23	0.0181	0.0065	2.76	0.0068
g24	0.0070	0.0081	0.86	0.3922
g25 [a]	0.0146	0.0070	2.10	0.0381
g33	-0.0762	0.0121	-6.29	<.0001
g34	0.0107	0.0081	1.32	0.1905
g35 [a]	0.0391	0.0083	4.72	<.0001
g44	-0.0649	0.0139	-4.65	<.0001
g55 [a]	-0.0919	0.0104	-8.80	<.0001
z1	0.0001	0.0012	0.10	0.9227
z2	0.0012	0.0009	1.37	0.1736
z3	-0.0005	0.0014	-0.32	0.7466
z4	-0.0016	0.0010	-1.58	0.1171
z5 [a]	0.0001	0.0011	0.11	0.9092

Table A.59: Parameter Estimates of Rotterdam Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
ρ11	-0.5493	0.0832	-6.60	<.0001
ρ12	-0.3692	0.0810	-4.56	<.0001
ρ21	-0.5792	0.0862	-6.72	<.0001
ρ22	-0.3097	0.0857	-3.61	0.0005
ρ31	-0.7674	0.0753	-10.19	<.0001
ρ32	-0.3710	0.0749	-4.95	<.0001
ρ41	-0.7772	0.0803	-9.68	<.0001
ρ42	-0.3507	0.0802	-4.37	<.0001
$R^2$1	0.5089			
$R^2$2	0.6820			
$R^2$3	0.7169			
$R^2$4	0.5548			
DW1	2.18			
DW2	2.02			
DW3	2.22			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.60: Parameter Estimates of CBS Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0471	0.0239	-1.97	0.0517
b2	-0.0151	0.0182	-0.83	0.4098
b3	0.1347	0.0269	5.01	<.0001
b4	-0.0848	0.0208	-4.08	<.0001
b5 [a]	-0.0084	0.0217	-0.39	0.6994
g11	-0.1293	0.0145	-8.91	<.0001
g12	0.0326	0.0083	3.95	0.0001
g13	0.0107	0.0084	1.28	0.2033
g14	0.0480	0.0103	4.67	<.0001
g15 [a]	0.0389	0.0088	4.42	<.0001
g22	-0.0744	0.0090	-8.30	<.0001
g23	0.0183	0.0065	2.80	0.0061
g24	0.0071	0.0081	0.87	0.3854
g25 [a]	0.0144	0.0070	2.07	0.0413
g33	-0.0771	0.0121	-6.36	<.0001
g34	0.0109	0.0081	1.34	0.1846

Table A.60: Parameter Estimates of CBS Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
g35 [a]	0.0393	0.0083	4.72	<.0001
g44	-0.0660	0.0139	-4.75	<.0001
g55 [a]	-0.0929	0.0105	-8.87	<.0001
z1	0.0000	0.0012	0.02	0.9855
z2	0.0012	0.0009	1.32	0.1886
z3	-0.0004	0.0014	-0.29	0.7755
z4	-0.0015	0.0010	-1.46	0.1463
z5 [a]	0.0001	0.0011	0.07	0.9425
ρ11	-0.5406	0.0832	-6.50	<.0001
ρ12	-0.3686	0.0809	-4.56	<.0001
ρ21	-0.5762	0.0865	-6.66	<.0001
ρ22	-0.3089	0.0861	-3.59	0.0005
ρ31	-0.7702	0.0754	-10.22	<.0001
ρ32	-0.3736	0.0750	-4.98	<.0001
ρ41	-0.7760	0.0802	-9.67	<.0001
ρ42	-0.3432	0.0801	-4.28	<.0001
$R^2$1	0.5110			
$R^2$2	0.6820			
$R^2$3	0.7168			
$R^2$4	0.5571			
DW1	2.17			
DW2	2.02			
DW3	2.22			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.61: Parameter Estimates of AIDS Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0460	0.0239	-1.92	0.0573
b2	-0.0161	0.0183	-0.88	0.3804
b3	0.1353	0.0269	5.03	<.0001
b4	-0.0858	0.0207	-4.15	<.0001
b5 [a]	-0.0078	0.0218	-0.36	0.7215
g11	0.0584	0.0145	4.03	0.0001
g12	-0.0045	0.0083	-0.55	0.5868
g13	-0.0367	0.0084	-4.38	<.0001
g14	-0.0057	0.0102	-0.56	0.5788

Table A.61: Parameter Estimates of AIDS Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
g15 [a]	-0.0105	0.0088	-1.19	0.2371
g22	0.0510	0.0090	5.67	<.0001
g23	-0.0096	0.0066	-1.46	0.1464
g24	-0.0241	0.0081	-2.98	0.0037
g25 [a]	-0.0148	0.0070	-2.12	0.0368
g33	0.0768	0.0121	6.36	<.0001
g34	-0.0288	0.0081	-3.57	0.0006
g35 [a]	0.0003	0.0083	0.03	0.9755
g44	0.1006	0.0138	7.27	<.0001
g55 [a]	0.0665	0.0105	6.34	<.0001
z1	0.0001	0.0012	0.06	0.9518
z2	0.0011	0.0009	1.24	0.2174
z3	-0.0004	0.0014	-0.28	0.7832
z4	-0.0015	0.0010	-1.48	0.1427
z5 [a]	0.0001	0.0011	0.09	0.9268
ρ11	-0.5428	0.0832	-6.52	<.0001
ρ12	-0.3662	0.0809	-4.53	<.0001
ρ21	-0.5716	0.0867	-6.59	<.0001
ρ22	-0.3059	0.0862	-3.55	0.0006
ρ31	-0.7691	0.0754	-10.20	<.0001
ρ32	-0.3753	0.0751	-4.99	<.0001
ρ41	-0.7812	0.0806	-9.69	<.0001
ρ42	-0.3392	0.0805	-4.21	<.0001
$R^2$1	0.5107			
$R^2$2	0.6791			
$R^2$3	0.7175			
$R^2$4	0.5612			
DW1	2.15			
DW2	2.01			
DW3	2.22			
DW4	2.14			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.62: Parameter Estimates of NBR Model for Peanut Butter Recall with Information Index for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	0.2066	0.0239	8.64	<.0001
b2	0.1309	0.0183	7.16	<.0001

Table A.62: Parameter Estimates of NBR Model for Peanut Butter Recall with Information Index for Post-event Period

b3	0.3226	0.0269	11.98	<.0001
b4	0.1255	0.0207	6.05	<.0001
b5 [a]	0.1943	0.0217	8.96	<.0001
g11	0.0585	0.0145	4.04	0.0001
g12	-0.0040	0.0083	-0.48	0.6321
g13	-0.0370	0.0084	-4.40	<.0001
g14	-0.0058	0.0102	-0.56	0.5748
g15 [a]	-0.0106	0.0088	-1.21	0.2293
g22	0.0506	0.0090	5.63	<.0001
g23	-0.0099	0.0066	-1.50	0.1365
g24	-0.0242	0.0081	-2.98	0.0036
g25 [a]	-0.0145	0.0070	-2.09	0.0397
g33	0.0778	0.0121	6.44	<.0001
g34	-0.0289	0.0081	-3.58	0.0005
g35 [a]	0.0001	0.0083	0.01	0.9906
g44	0.1017	0.0139	7.32	<.0001
g55 [a]	0.0675	0.0105	6.46	<.0001
z1	0.0002	0.0012	0.14	0.8911
z2	0.0012	0.0009	1.29	0.2005
z3	-0.0004	0.0014	-0.31	0.7549
z4	-0.0016	0.0010	-1.60	0.1137
z5 [a]	0.0001	0.0011	0.13	0.8930
ρ11	-0.5513	0.0832	-6.62	<.0001
ρ12	-0.3667	0.0809	-4.53	<.0001
ρ21	-0.5748	0.0864	-6.65	<.0001
ρ22	-0.3068	0.0858	-3.57	0.0006
ρ31	-0.7665	0.0753	-10.18	<.0001
ρ32	-0.3727	0.0750	-4.97	<.0001
ρ41	-0.7823	0.0807	-9.70	<.0001
ρ42	-0.3467	0.0806	-4.30	<.0001
$R^2$1	0.5081			
$R^2$2	0.6792			
$R^2$3	0.7177			
$R^2$4	0.5591			
DW1	2.15			
DW2	2.02			
DW3	2.22			
DW4	2.14			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of sentiment index.

Table A.63: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-1.8419	0.6229	-2.96	0.0051
b2	-1.1324	0.3541	-3.20	0.0026
b3	-1.3176	0.4810	-2.74	0.0090
b4	-1.5901	0.5298	-3.00	0.0045
b5 [a]	-1.5133	0.4969	-3.05	0.0040
g11	-0.1680	0.2546	-0.66	0.5129
g12	0.0492	0.0499	0.99	0.3299
g13	0.0440	0.0658	0.67	0.5074
g14	-0.0005	0.0757	-0.01	0.9948
g15 [a]	0.0578	0.0691	0.84	0.4076
g22	-0.1270	0.1659	-0.77	0.4483
g23	0.0166	0.0376	0.44	0.6618
g24	0.0369	0.0442	0.84	0.4084
g25 [a]	0.0173	0.0396	0.44	0.6648
g33	-0.1263	0.2065	-0.61	0.5441
g34	0.0552	0.0540	1.02	0.3126
g35 [a]	-0.0069	0.0539	-0.13	0.8985
g44	-0.1438	0.2253	-0.64	0.5267
g55 [a]	-0.1121	0.2145	-0.52	0.6038
z1	-0.0350	0.0342	-1.02	0.3123
z2	-0.0095	0.0209	-0.45	0.6518
z3	0.0084	0.0522	0.16	0.8728
z4	0.0281	0.0259	1.08	0.2842
z5 [a]	0.0103	0.0326	0.32	0.7530
y1	-0.0653	0.0355	-1.84	0.0729
y2	-0.0238	0.0218	-1.09	0.2814
y3	0.0480	0.0522	0.92	0.3631
y4	0.0342	0.0279	1.23	0.2269
y5 [a]	0.0067	0.0357	0.19	0.8526
x1	0.0176	0.0383	0.46	0.6486
x2	-0.0201	0.0231	-0.87	0.3885
x3	0.0365	0.0578	0.63	0.5314
x4	-0.0339	0.0286	-1.18	0.2431
x5 [a]	-0.0005	0.0357	-0.01	0.9886
v1	-0.0320	0.1156	-0.28	0.7833
v2	0.2494	0.0667	3.74	0.0006
v3	-0.3254	0.1644	-1.98	0.0544
v4	0.0880	0.0855	1.03	0.3095
v5 [a]	0.0153	0.1035	0.15	0.8829
λ	8.3725	2.4766	3.38	0.0016
μ	-0.4009	1.3456	-0.30	0.7672
$\rho 1$	-0.5899	0.1003	-5.88	<.0001

Table A.63: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
ρ2	-0.6256	0.1120	-5.58	<.0001
ρ3	-0.4877	0.0989	-4.93	<.0001
ρ4	-0.5826	0.1196	-4.87	<.0001
$R^2$1	0.5698			
$R^2$2	0.8229			
$R^2$3	0.6563			
$R^2$4	0.7167			
DW1	2.46			
DW2	2.58			
DW3	2.53			
DW4	2.58			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first and second lag of negative sentiment index and v is the coefficent of positive sentiment index.

Table A.64: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0238	0.3179	-0.07	0.9404
b2	0.0015	0.1865	0.01	0.9935
b3	0.1383	0.2367	0.58	0.5604
b4	-0.0803	0.2674	-0.30	0.7647
b5 [a]	0.0829	0.2581	0.32	0.7488
g11	-0.0373	0.1678	-0.22	0.8248
g12	0.0157	0.0340	0.46	0.6449
g13	-0.0131	0.0430	-0.30	0.7621
g14	0.0201	0.0491	0.41	0.6839
g15 [a]	0.0142	0.0447	0.32	0.7512
g22	-0.0141	0.1120	-0.13	0.8998
g23	0.0035	0.0257	0.14	0.8909
g24	-0.0081	0.0289	-0.28	0.7807
g25 [a]	0.0007	0.0270	0.02	0.9805
g33	-0.0018	0.1376	-0.01	0.9897
g34	-0.0071	0.0363	-0.20	0.8455
g35 [a]	0.0196	0.0355	0.55	0.5832
g44	0.0161	0.1495	0.11	0.9143
g55 [a]	-0.0126	0.1424	-0.09	0.9297
z1	0.0140	0.0221	0.63	0.5286

Table A.64: Parameter Estimates of Synthetic Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
z2	0.0332	0.0164	2.02	0.0464
z3	-0.0232	0.0259	-0.90	0.3729
z4	-0.0239	0.0186	-1.29	0.2017
z5 [a]	-0.0047	0.0203	-0.23	0.8175
v1	-0.0186	0.0689	-0.27	0.7875
v2	-0.0337	0.0524	-0.64	0.5215
v3	0.0254	0.0890	0.28	0.7763
v4	0.0084	0.0634	0.13	0.8954
v5 [a]	0.0121	0.0708	0.17	0.8645
λ	0.9391	1.2589	0.75	0.4575
μ	0.4846	0.8906	0.54	0.5876
ρ11	-0.5706	0.0831	-6.86	<.0001
ρ12	-0.3698	0.0825	-4.48	<.0001
ρ21	-0.5790	0.0884	-6.55	<.0001
ρ22	-0.2896	0.0881	-3.29	0.0014
ρ31	-0.7797	0.0765	-10.20	<.0001
ρ32	-0.3751	0.0768	-4.88	<.0001
ρ41	-0.7852	0.0813	-9.66	<.0001
ρ42	-0.3474	0.0815	-4.26	<.0001
$R^2$1	0.5145			
$R^2$2	0.6878			
$R^2$3	0.7207			
$R^2$4	0.5570			
DW1	2.16			
DW2	2.00			
DW3	2.21			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of negative sentiment index and v is the coefficients for no lag of positive sentiment index.

Table A.65: Parameter Estimates of Rotterdam Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	0.2130	0.0246	8.65	<.0001
b2	0.1405	0.0187	7.52	<.0001
b3	0.3132	0.0279	11.24	<.0001
b4	0.1185	0.0223	5.31	<.0001
b5 [a]	0.1926	0.0227	8.50	<.0001
g11	-0.1281	0.0145	-8.83	<.0001

Table A.65: Parameter Estimates of Rotterdam Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

g12	0.0342	0.0083	4.13	<.0001
g13	0.0095	0.0085	1.12	0.2650
g14	0.0460	0.0104	4.40	<.0001
g15 [a]	0.0390	0.0089	4.41	<.0001
g22	-0.0753	0.0089	-8.46	<.0001
g23	0.0168	0.0065	2.57	0.0118
g24	0.0070	0.0081	0.86	0.3924
g25 [a]	0.0155	0.0069	2.23	0.0279
g33	-0.0754	0.0122	-6.19	<.0001
g34	0.0121	0.0082	1.47	0.1440
g35 [a]	0.0391	0.0084	4.67	<.0001
g44	-0.0638	0.0142	-4.47	<.0001
g55 [a]	-0.0925	0.0105	-8.78	<.0001
z1	0.0144	0.0220	0.65	0.5141
z2	0.0346	0.0163	2.13	0.0359
z3	-0.0251	0.0257	-0.98	0.3312
z4	-0.0244	0.0187	-1.31	0.1943
z5 [a]	-0.0047	0.0202	-0.23	0.8188
v1	-0.0155	0.0689	-0.22	0.8229
v2	-0.0335	0.0521	-0.64	0.5227
v3	0.0255	0.0888	0.29	0.7744
v4	0.0006	0.0625	0.01	0.9924
v5 [a]	0.0159	0.0703	0.23	0.8216
ρ11	-0.5765	0.0828	-6.96	<.0001
ρ12	-0.3714	0.0823	-4.51	<.0001
ρ21	-0.5841	0.0878	-6.65	<.0001
ρ22	-0.2903	0.0875	-3.32	0.0013
ρ31	-0.7771	0.0759	-10.24	<.0001
ρ32	-0.3715	0.0762	-4.87	<.0001
ρ41	-0.7833	0.0807	-9.70	<.0001
ρ42	-0.3552	0.0810	-4.39	<.0001
$R^2$1	0.5123			
$R^2$2	0.6893			
$R^2$3	0.7203			
$R^2$4	0.5517			
DW1	2.17			
DW2	2.01			
DW3	2.21			
DW4	2.12			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of negative sentiment index and v is the coefficients for no lag of positive sentiment index.

Table A.66: Parameter Estimates of CBS Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0399	0.0246	-1.62	0.1078
b2	-0.0069	0.0187	-0.37	0.7144
b3	0.1267	0.0279	4.55	<.0001
b4	-0.0927	0.0222	-4.17	<.0001
b5 [a]	-0.0096	0.0227	-0.42	0.6739
g11	-0.1282	0.0145	-8.82	<.0001
g12	0.0337	0.0083	4.06	0.0001
g13	0.0100	0.0085	1.18	0.2422
g14	0.0461	0.0104	4.42	<.0001
g15 [a]	0.0392	0.0089	4.43	<.0001
g22	-0.0749	0.0089	-8.42	<.0001
g23	0.0171	0.0065	2.61	0.0104
g24	0.0070	0.0081	0.87	0.3875
g25	0.0153	0.0070	2.19	0.0307
g33	-0.0765	0.0122	-6.27	<.0001
g34	0.0121	0.0082	1.48	0.1420
g35 [a]	0.0393	0.0084	4.68	<.0001
g44	-0.0647	0.0142	-4.56	<.0001
g55 [a]	-0.0935	0.0106	-8.86	<.0001
z1	0.0133	0.0220	0.61	0.5464
z2	0.0334	0.0163	2.05	0.0431
z3	-0.0226	0.0257	-0.88	0.3805
z4	-0.0240	0.0186	-1.29	0.2014
z5 [a]	-0.0053	0.0203	-0.26	0.7953
v1	-0.0193	0.0685	-0.28	0.7789
v2	-0.0328	0.0521	-0.63	0.5309
v3	0.0238	0.0889	0.27	0.7894
v4	0.0091	0.0622	0.15	0.8845
v5 [a]	0.0116	0.0704	0.16	0.8698
ρ11	-0.5684	0.0829	-6.86	<.0001
ρ12	-0.3706	0.0823	-4.50	<.0001
ρ21	-0.5803	0.0881	-6.59	<.0001
ρ22	-0.2904	0.0878	-3.31	0.0013
ρ31	-0.7797	0.0760	-10.26	<.0001
ρ32	-0.3740	0.0764	-4.90	<.0001
ρ41	-0.7826	0.0807	-9.70	<.0001
ρ42	-0.3490	0.0810	-4.31	<.0001
$R^2$1	0.5143			
$R^2$2	0.6888			
$R^2$3	0.7197			
$R^2$4	0.5549			

Table A.66: Parameter Estimates of CBS Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
DW1	2.17			
DW2	2.00			
DW3	2.21			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficient for no lag of negative sentiment index and v is the coefficient for no lag of positive sentiment index.

Table A.67: Parameter Estimates of AIDS Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.0385	0.0246	-1.57	0.1206
b2	-0.0081	0.0188	-0.43	0.6666
b3	0.1272	0.0279	4.57	<.0001
b4	-0.0936	0.0221	-4.23	<.0001
b5 [a]	-0.0089	0.0228	-0.39	0.6978
g11	0.0595	0.0145	4.10	<.0001
g12	-0.0035	0.0083	-0.42	0.6753
g13	-0.0375	0.0085	-4.43	<.0001
g14	-0.0076	0.0104	-0.73	0.4644
g15 [a]	-0.0102	0.0088	-1.15	0.2534
g22	0.0505	0.0089	5.67	<.0001
g23	-0.0108	0.0066	-1.65	0.1017
g24	-0.0241	0.0081	-2.98	0.0037
g25 [a]	-0.0139	0.0070	-2.00	0.0487
g33	0.0775	0.0122	6.38	<.0001
g34	-0.0275	0.0081	-3.38	0.0010
g35 [a]	0.0003	0.0084	0.04	0.9703
g44	0.1020	0.0141	7.21	<.0001
g55 [a]	0.0660	0.0106	6.24	<.0001
z1	0.0145	0.0220	0.66	0.5126
z2	0.0328	0.0164	2.00	0.0482
z3	-0.0234	0.0256	-0.91	0.3632
z4	-0.0238	0.0185	-1.29	0.2014
z5 [a]	-0.0047	0.0203	-0.23	0.8191
v1	-0.0184	0.0685	-0.27	0.7894
v2	-0.0346	0.0523	-0.66	0.5101
v3	0.0268	0.0887	0.30	0.7633
v4	0.0086	0.0619	0.14	0.8893

Table A.67: Parameter Estimates of AIDS Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
v5 [a]	0.0087	0.0705	0.12	0.9025
ρ11	-0.5710	0.0829	-6.89	<.0001
ρ12	-0.3684	0.0821	-4.49	<.0001
ρ21	-0.5762	0.0882	-6.53	<.0001
ρ22	-0.2882	0.0880	-3.28	0.0015
ρ31	-0.7787	0.0760	-10.24	<.0001
ρ32	-0.3757	0.0764	-4.91	<.0001
ρ41	-0.7871	0.0811	-9.70	<.0001
ρ42	-0.3445	0.0815	-4.23	<.0001
$R^2$1	0.5144			
$R^2$2	0.6860			
$R^2$3	0.7207			
$R^2$4	0.5589			
DW1	2.15			
DW2	2.00			
DW3	2.22			
DW4	2.13			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of negative sentiment index and v is the coefficients for no lag of positive sentiment index.

Table A.68: Parameter Estimates of NBR Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	0.2144	0.0246	8.71	<.0001
b2	0.1393	0.0188	7.42	<.0001
b3	0.3137	0.0279	11.26	<.0001
b4	0.1176	0.0222	5.30	<.0001
b5 [a]	0.1934	0.0227	8.52	<.0001
g11	0.0597	0.0145	4.12	<.0001
g12	-0.0030	0.0083	-0.36	0.7231
g13	-0.0379	0.0085	-4.46	<.0001
g14	-0.0077	0.0104	-0.74	0.4620
g15 [a]	-0.0104	0.0088	-1.17	0.2431
g22	0.0502	0.0089	5.63	<.0001
g23	-0.0111	0.0066	-1.70	0.0925
g24	-0.0242	0.0081	-2.98	0.0037
g25 [a]	-0.0137	0.0070	-1.96	0.0526
g33	0.0786	0.0121	6.47	<.0001

Table A.68: Parameter Estimates of NBR Model for Peanut Butter Recall with Positive and Negative Sentiment Indices for Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
g34	-0.0275	0.0082	-3.37	0.0011
g35 [a]	0.0001	0.0084	0.01	0.9924
g44	0.1029	0.0142	7.25	<.0001
g55 [a]	0.0670	0.0105	6.36	<.0001
z1	0.0155	0.0220	0.70	0.4827
z2	0.0340	0.0164	2.08	0.0402
z3	-0.0259	0.0257	-1.01	0.3156
z4	-0.0243	0.0186	-1.31	0.1943
z5 [a]	-0.0040	0.0202	-0.20	0.8429
v1	-0.0145	0.0689	-0.21	0.8344
v2	-0.0353	0.0523	-0.67	0.5020
v3	0.0284	0.0886	0.32	0.7489
v4	0.0001	0.0622	0.00	0.9984
v5 [a]	0.0130	0.0703	0.19	0.8535
ρ11	-0.5788	0.0828	-6.99	<.0001
ρ12	-0.3692	0.0821	-4.50	<.0001
ρ21	-0.5802	0.0880	-6.60	<.0001
ρ22	-0.2882	0.0876	-3.29	0.0014
ρ31	-0.7761	0.0759	-10.23	<.0001
ρ32	-0.3732	0.0763	-4.89	<.0001
ρ41	-0.7878	0.0812	-9.71	<.0001
ρ42	-0.3505	0.0815	-4.30	<.0001
$R^2$1	0.5119			
$R^2$2	0.6867			
$R^2$3	0.7214			
$R^2$4	0.5559			
DW1	2.15			
DW2	2.00			
DW3	2.22			
DW4	2.12			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z is the coefficients for no lag of negative sentiment index and v is the coefficients for no lag of positive sentiment index.

APPENDIX B: REFRIGERATED COOKIE DOUGH RECALL

Table B.1 : Test of Nested Models for Refrigerated Cookie Dough with Information Index in the Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	5.47	0.0648
CBS	λ=1, μ=0	1.6	0.4497
AIDS	λ=1, μ=1	3.11	0.2110
NBR	λ=0, μ=1	7.19	0.0275

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table B.2 : Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities of Refrigerated Cookie Dough Brands with Information Index in Pre-event period

	Uncompensated Own-price Elasticity	Expenditure Elasticity	Information Elasticity
Brand1	-1.0166***	0.7390***	-0.0144
Brand2	-0.6856***	0.4305***	-0.0060
Store Brand	-0.6993***	0.5036***	0.0052
Other Brand	-0.7591***	2.3963***	0.0190

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.3: Estimated Compensated Own-Price and Cross-Price Elasticities of Synthetic Model for Refrigerated Cookie Dough Brands with Information Index in Pre-Event Period

	Brand1	Brand2	Store Brand	Other Brand
Brand1	-0.8125***	0.4039***	0.2860***	0.1225***
Brand2	0.3927***	-0.5633***	0.1388**	0.0318
Store Brand	0.3890**	0.2180**	-0.6248***	0.0086
Other Brand	0.1417***	0.0378	0.0072	-0.1866**

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.4: Test of Nested Models for Refrigerated Cookie Dough with Information Index in the Post-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	26.11	<.0001
CBS	λ=1, μ=0	11.87	0.0026
AIDS	λ=1, μ=1	14.59	0.0007
NBR	λ=0, μ=1	30.34	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table B.5: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities of Refrigerated Cookie Dough Brands with Information Index in Post-event period

	Uncompensated Own-price Elasticity	Expenditure Elasticity	Information Elasticity
Brand1	-0.57606***	0.468117***	-0.03108*
Brand2	-0.65448***	0.493782***	0.0108
Store Brand	-0.50882***	0.546491***	0.00036
Other Brand	-0.87247***	2.466296***	0.01776

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.6: Estimated Compensated Own-Price and Cross-Price Elasticities of Synthetic Model for Refrigerated Cookie Dough Brands with Information Index in Post-Event Period

	Brand1	Brand2	Store Brand	Other Brand
Brand1	-0.4583***	0.2808***	0.0743	0.1123**
Brand2	0.2435***	-0.51122***	0.2078**	0.0917**
Store Brand	0.0917	0.295817**	-0.3973**	0.0098
Other Brand	0.1110**	0.104603**	0.0140	-0.2297***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.7: Test of Nested Models for Refrigerated Cookie Dough Positive and Negative Sentiment Indices in Pre-event period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	5.57	0.0616
CBS	λ=1, μ=0	1.87	0.3925
AIDS	λ=1, μ=1	2.88	0.2364
NBR	λ=0, μ=1	6.92	0.0314

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table B.8: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities of Refrigerated Cookie Dough Brands with Positive and Negative Sentiment Indices in Pre-event period

	Uncompensated Own-price Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive sentiment Elasticity
Brand1	-1.0828***	0.4649***	-0.1624	1.3680
Brand2	-0.7387***	0.5141***	0.0670	-0.5674
Store Brand	-0.7363***	2.2164***	-0.0202	-0.1026
Other Brand	-0.7581***	2.2620***	0.1218	-0.7207

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.9: Estimated Compensated Own-Price and Cross-Price Elasticities of Synthetic Model for Refrigerated Cookie Dough Brands with Positive and Negative Sentiment Indices in Pre-Event Period

	Brand1	Brand2	Store Brand	Other Brand
Brand1	-0.8477***	0.4223***	0.28145***	0.1423***
Brand2	0.41059***	-0.6067***	0.16026**	0.03572
Store Brand	0.38704***	0.22667**	-0.6331***	0.01274
Other Brand	0.1645***	0.042474	0.010711	-0.21773***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.10: Test of Nested Models for Refrigerated Cookie Dough Positive and Negative Sentiment Indices in Post-event period

Model	Test	χ^2 Statistics	P-value
Rotterdam	$\lambda=0, \mu=0$	28.44	<.0001
CBS	$\lambda=1, \mu=0$	13.49	0.0012
AIDS	$\lambda=1, \mu=1$	16.07	0.0003
NBR	$\lambda=0, \mu=1$	32.46	<.0001

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

Table B.11: Estimated Uncompensated Own-Price, Expenditure and Sentiment Elasticities of Refrigerated Cookie Dough Brands with Positive and Negative Sentiment Indices in Post-event period

	Uncompensated Own-price Elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive sentiment Elasticity
Brand1	-0.6098	0.55584	-0.9977**	0.37394
Brand2	-0.6522	0.4732	0.00277	0.46947
Store Brand	-0.5202	0.53901	-0.0377	1.23883
Other Brand	-0.86271	2.40906	1.01612	-1.9105

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B.12: Estimated Compensated Own-Price and Cross-Price Elasticities of Synthetic Model for Refrigerated Cookie Dough Brands with Positive and Negative Sentiment Indices in Post-Event Period

	Brand1	Brand2	Store Brand	Other Brand
Brand1	-0.4700***	0.2843***	0.0800	0.1070**
Brand2	0.2464***	-0.5149***	0.2051**	0.0963**
Store Brand	0.0987	0.2919**	-0.4103***	0.0154
Other Brand	0.1057**	0.1098**	0.0123	-0.2279***

*indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table B13: Parameter Estimates for Synthetic Model for Refrigerated Cookie Dough

	Pre-event			Post-event		
Parameter	Estimate	Std. Error	P-value	Estimate	Std. Error	P-value
b1	-0.3756	0.2441	0.1288	-0.6835	0.1478	<.0001
b2	-0.4828	0.2509	0.0587	-0.8158	0.1755	<.0001
b3	-0.3280	0.1755	0.0662	-0.5637	0.1198	<.0001
b4 [a]	0.0276	0.2288	0.9042	-0.1984	0.1721	0.2532
g11	-0.1535	0.1142	0.1834	0.0213	0.1336	0.8737
g12	0.0824	0.0484	0.0932	0.0207	0.0557	0.7112
g13	0.0584	0.0353	0.1024	-0.0211	0.0399	0.6001
g14 [a]	0.0145	0.0368	0.6948	-0.0174	0.0463	0.7090
g22	-0.0876	0.1142	0.4459	-0.0065	0.1485	0.9652
g23	0.0211	0.0357	0.5568	0.0167	0.0474	0.7257
g24 [a]	-0.0138	0.0368	0.7097	-0.0193	0.0540	0.7213
g33	-0.0648	0.0899	0.4737	0.0344	0.1171	0.7696
g34 [a]	-0.0153	0.0267	0.5677	-0.0367	0.0394	0.3550
g44 [a]	0.0141	0.0980	0.8859	0.0659	0.1362	0.6300
λ	2.1467	0.8871	0.0183	3.2868	0.6037	<.0001
μ	0.3843	0.5439	0.4823	0.7177	0.7187	0.3217
z1	-0.1001	0.0647	0.1265	-0.0345	0.0799	0.6676
y1	0.0690	0.0653	0.2948	-0.1248	0.0721	0.0882
x1	-0.0404	0.0642	0.5315	-0.2160	0.0809	0.0096
z2	0.0143	0.0546	0.7947	0.0905	0.0891	0.3136
y2	-0.0027	0.0551	0.9615	0.0418	0.0843	0.6215
x2	0.0186	0.0544	0.7337	-0.0371	0.0898	0.6806
z3	0.0149	0.0551	0.7873	0.0266	0.0759	0.7272
y3	0.0165	0.0563	0.7701	0.0715	0.0700	0.3108
x3	-0.0069	0.0550	0.9002	-0.0068	0.0777	0.9305
z4 [a]	0.0747	0.1192	0.5331	-0.0666	0.1269	0.6016
y4 [a]	-0.0857	0.1216	0.4831	-0.0129	0.1246	0.9180
x4 [a]	0.0391	0.1189	0.7434	0.2634	0.1192	0.0306
ρ1	-0.4160	0.1100	0.0003	-0.4758	0.1179	0.0001
ρ2	-0.3812	0.1150	0.0015	-0.3107	0.1183	0.0108
ρ3	-0.4781	0.1116	<.0001	-0.4670	0.1212	0.0003
$R^2$1	0.6194			0.5963		
$R^2$2	0.5836			0.3761		
$R^2$3	0.3948			0.4039		
DW1	2.1095			2.1800		
DW2	2.1712			2.2231		
DW3	2.0442			2.1872		

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Brand1, 2 is Brand2, 3 is Store brand and 4 is Other brands.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of sentiment index.

Table B14: Parameter Estimates for Rotterdam Model for Refrigerated Cookie Dough

	Pre-event			Post-event		
Parameter	Estimate	Std. Error	P-value	Estimate	Std. Error	P-value
b1	0.2073	0.0328	<.0001	0.1095	0.0299	0.0005
b2	0.1177	0.0276	<.0001	0.1259	0.0314	0.0002
b3	0.0905	0.0259	0.0009	0.0658	0.0293	0.0279
b4[a]	0.5856	0.0594	<.0001	0.7053	0.0473	<.0001
g11	-0.2322	0.0192	<.0001	-0.1055	0.0238	<.0001
g12	0.1140	0.0161	<.0001	0.0715	0.0206	0.0009
g13	0.0800	0.0164	<.0001	0.0196	0.0205	0.3435
g14[a]	0.0386	0.0105	0.0005	0.0183	0.0111	0.1047
g22	-0.1678	0.0230	<.0001	-0.1433	0.0291	<.0001
g23	0.0456	0.0192	0.0203	0.0495	0.0237	0.0404
g24[a]	0.0079	0.0089	0.3758	0.0305	0.0118	0.0118
g33	-0.1278	0.0249	<.0001	-0.0748	0.0308	0.0178
g34[a]	0.0010	0.0085	0.9058	0.0102	0.0118	0.3871
g44[a]	-0.0468	0.0192	0.0178	-0.0543	0.0191	0.0059
z1	-0.0885	0.0667	0.1896	-0.0265	0.0869	0.7613
y1	0.0620	0.0676	0.3620	-0.1237	0.0781	0.1179
x1	-0.0392	0.0666	0.5584	-0.2104	0.0878	0.0194
z2	0.0134	0.0562	0.8118	0.0779	0.0899	0.3897
y2	-0.0097	0.0567	0.8646	0.0383	0.0837	0.6482
x2	0.0032	0.0557	0.9542	-0.0269	0.0911	0.7684
z3	0.0211	0.0533	0.6937	0.0387	0.0819	0.6384
y3	-0.0045	0.0540	0.9340	0.0950	0.0757	0.2138
x3	-0.0247	0.0529	0.6416	0.0003	0.0839	0.9970
z4[a]	0.0562	0.1215	0.6449	-0.0579	0.1446	0.6903
y4[a]	-0.0493	0.1234	0.6909	-0.0362	0.1413	0.7984
x4[a]	0.0682	0.1210	0.5749	0.2651	0.1355	0.0547
ρ1	-0.3863	0.1101	0.0008	-0.4641	0.1163	0.0002
ρ2	-0.3781	0.1144	0.0015	-0.3970	0.1185	0.0013
ρ3	-0.5070	0.1096	<.0001	-0.4675	0.1274	0.0005
$R^2$1	0.5860			0.5183		
$R^2$2	0.5524			0.3598		
$R^2$3	0.4243			0.2973		
DW1	2.0710			2.2216		
DW2	2.1666			2.0686		
DW3	2.0507			2.1969		

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Brand1, 2 is Brand2, 3 is Store brand and 4 is Other brands.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of sentiment index.

Table B15: Parameter Estimates for CBS Model for Refrigerated Cookie Dough

	Pre-event			Post-event		
Parameter	Estimate	Std. Error	P-value	Estimate	Std. Error	P-value
b1	-0.0635	0.0320	0.0518	-0.1329	0.0287	<.0001
b2	-0.1634	0.0271	<.0001	-0.1616	0.0309	<.0001
b3	-0.1049	0.0261	0.0001	-0.1237	0.0281	<.0001
b4[a]	0.3359	0.0582	<.0001	0.4287	0.0447	<.0001
g11	-0.2326	0.0191	<.0001	-0.1065	0.0228	<.0001
g12	0.1145	0.0159	<.0001	0.0713	0.0204	0.0009
g13	0.0800	0.0164	<.0001	0.0177	0.0199	0.3780
g14[a]	0.0382	0.0103	0.0004	0.0208	0.0106	0.0547
g22	-0.1674	0.0227	<.0001	-0.1465	0.0295	<.0001
g23	0.0439	0.0190	0.0242	0.0535	0.0238	0.0282
g24[a]	0.0087	0.0088	0.3249	0.0304	0.0116	0.0109
g33	-0.1265	0.0249	<.0001	-0.0774	0.0306	0.0139
g34[a]	0.0015	0.0086	0.8638	0.0109	0.0113	0.3423
g44[a]	-0.0477	0.0189	0.0139	-0.0571	0.0180	0.0023
z1	-0.4032	0.1095	0.0005	-0.4745	0.1158	0.0001
y1	-0.3821	0.1143	0.0014	-0.3603	0.1182	0.0033
x1	-0.4940	0.1101	<.0001	-0.4846	0.1247	0.0002
z2	-0.0936	0.0653	0.1564	-0.0305	0.0833	0.7153
y2	0.0650	0.0661	0.3288	-0.1213	0.0747	0.1095
x2	-0.0394	0.0651	0.5467	-0.2129	0.0843	0.0140
z3	0.0141	0.0552	0.7986	0.0842	0.0883	0.3438
y3	-0.0071	0.0557	0.8994	0.0381	0.0828	0.6469
x3	0.0091	0.0547	0.8681	-0.0292	0.0893	0.7448
z4[a]	0.0183	0.0536	0.7346	0.0351	0.0790	0.6584
y4[a]	0.0052	0.0543	0.9239	0.0858	0.0726	0.2417
x4[a]	-0.0164	0.0532	0.7591	-0.0006	0.0809	0.9941
ρ1	0.0639	0.1191	0.5934	-0.0610	0.1362	0.6556
ρ2	-0.0646	0.1209	0.5948	-0.0295	0.1331	0.8256
ρ3	0.0559	0.1186	0.6389	0.2627	0.1279	0.0440
$R^2$1	0.6050			0.5571		
$R^2$2	0.5682			0.3802		
$R^2$3	0.4186			0.3481		
DW1	2.0968			2.2318		
DW2	2.1758			2.1427		
DW3	2.0556			2.2024		

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Brand1, 2 is Brand2, 3 is Store brand and 4 is Other brands.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of sentiment index.

Table B16: Parameter Estimates for AIDS Model for Refrigerated Cookie Dough

	Pre-event			Post-event		
Parameter	Estimate	Std. Error	P-value	Estimate	Std. Error	P-value
b1	-0.0661	0.0322	0.0439	-0.1285	0.0283	<.0001
b2	-0.1557	0.0271	<.0001	-0.1590	0.0311	<.0001
b3	-0.1018	0.0266	0.0003	-0.1278	0.0286	<.0001
b4[a]	0.3268	0.0598	<.0001	0.4234	0.0447	<.0001
g11	-0.0258	0.0189	0.1760	0.0767	0.0230	0.0014
g12	0.0303	0.0157	0.0581	0.0006	0.0207	0.9757
g13	0.0234	0.0164	0.1580	-0.0315	0.0199	0.1184
g14[a]	-0.0277	0.0103	0.0091	-0.0428	0.0106	0.0001
g22	0.0382	0.0226	0.0957	0.0564	0.0298	0.0629
g23	-0.0109	0.0190	0.5674	-0.0054	0.0239	0.8211
g24[a]	-0.0577	0.0088	<.0001	-0.0429	0.0117	0.0005
g33	0.0310	0.0248	0.2164	0.0830	0.0305	0.0083
g34[a]	-0.0447	0.0088	<.0001	-0.0417	0.0114	0.0005
g44[a]	0.1309	0.0194	<.0001	0.1324	0.0180	<.0001
z1	-0.3896	0.1088	0.0006	-0.4868	0.1161	<.0001
y1	-0.3675	0.1144	0.0020	-0.3838	0.1180	0.0018
x1	-0.4968	0.1097	<.0001	-0.4650	0.1252	0.0004
z2	-0.0948	0.0655	0.1525	-0.0214	0.0827	0.7962
y2	0.0668	0.0663	0.3178	-0.1314	0.0739	0.0800
x2	-0.0406	0.0653	0.5359	-0.2146	0.0837	0.0127
z3	0.0126	0.0551	0.8203	0.0728	0.0890	0.4168
y3	-0.0033	0.0556	0.9531	0.0438	0.0830	0.5994
x3	0.0161	0.0546	0.7693	-0.0318	0.0901	0.7252
z4[a]	0.0174	0.0548	0.7523	0.0342	0.0799	0.6700
y4[a]	0.0064	0.0555	0.9089	0.0903	0.0738	0.2258
x4[a]	-0.0165	0.0544	0.7624	-0.0047	0.0818	0.9543
ρ1	0.0687	0.1223	0.5763	-0.0580	0.1360	0.6712
ρ2	-0.0722	0.1242	0.5630	-0.0267	0.1328	0.8411
ρ3	0.0511	0.1218	0.6764	0.2711	0.1278	0.0377
$R^2$1	0.6013			0.5655		
$R^2$2	0.5698			0.3728		
$R^2$3	0.3915			0.3306		
DW1	2.0519			2.2260		
DW2	2.1460			2.1208		
DW3	2.0302			2.1949		

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Brand1, 2 is Brand2, 3 is Store brand and 4 is Other brands.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of sentiment index.

Table B17: Parameter Estimates for NBR Model for Refrigerated Cookie Dough

	Pre-event			Post-event		
Parameter	Estimate	Std. Error	P-value	Estimate	Std. Error	P-value
b1	0.2045	0.0330	<.0001	0.1139	0.0295	0.0003
b2	0.1253	0.0276	<.0001	0.1286	0.0316	0.0001
b3	0.0935	0.0265	0.0008	0.0611	0.0299	0.0450
b4[a]	0.5768	0.0610	<.0001	0.7001	0.0475	<.0001
g11	-0.0254	0.0190	0.1865	0.0780	0.0240	0.0019
g12	0.0299	0.0159	0.0652	0.0010	0.0208	0.9607
g13	0.0234	0.0164	0.1573	-0.0302	0.0206	0.1470
g14[a]	-0.0274	0.0106	0.0117	-0.0453	0.0111	0.0001
g22	0.0378	0.0230	0.1044	0.0597	0.0294	0.0462
g23	-0.0094	0.0192	0.6241	-0.0099	0.0238	0.6795
g24[a]	-0.0584	0.0089	<.0001	-0.0429	0.0119	0.0006
g33	0.0300	0.0250	0.2338	0.0866	0.0306	0.0062
g34[a]	-0.0452	0.0087	<.0001	-0.0425	0.0119	0.0007
g44[a]	0.1319	0.0197	<.0001	0.1353	0.0192	<.0001
z1	-0.3717	0.1094	0.0012	-0.4770	0.1167	0.0001
y1	-0.3642	0.1145	0.0022	-0.4206	0.1181	0.0007
x1	-0.5073	0.1093	<.0001	-0.4407	0.1277	0.0010
z2	-0.0898	0.0670	0.1845	-0.0172	0.0862	0.8423
y2	0.0638	0.0679	0.3503	-0.1337	0.0772	0.0878
x2	-0.0405	0.0668	0.5462	-0.2125	0.0872	0.0176
z3	0.0118	0.0561	0.8343	0.0658	0.0910	0.4724
y3	-0.0059	0.0566	0.9177	0.0446	0.0842	0.5980
x3	0.0101	0.0556	0.8568	-0.0308	0.0922	0.7392
z4[a]	0.0204	0.0545	0.7099	0.0377	0.0832	0.6518
y4[a]	-0.0035	0.0553	0.9501	0.1000	0.0774	0.2008
x4[a]	-0.0248	0.0541	0.6476	-0.0034	0.0852	0.9680
ρ1	0.0609	0.1245	0.6263	-0.0546	0.1451	0.7081
ρ2	-0.0566	0.1264	0.6558	-0.0337	0.1417	0.8126
ρ3	0.0634	0.1240	0.6110	0.2741	0.1361	0.0481
$R^2$1	0.5818			0.5277		
$R^2$2	0.5538			0.3467		
$R^2$3	0.3971			0.2713		
DW1	2.0273			2.2152		
DW2	2.1362			2.0427		
DW3	2.0254			2.1857		

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Brand1, 2 is Brand2, 3 is Store brand and 4 is Other brands.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of sentiment index.

APPENDIX C: GULF OIL SPILL EVENT

Table C.1: Test of Nested Models for Meat Products using Information Index

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	80.77	<.0001
CBS	λ=1, μ=0	52	<.0001
AIDS	λ=1, μ=1	14.55	0.0007
NBR	λ=0, μ=1	40.59	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.2: Uncompensated Own-Price, Expenditure and Sentiment Elasticity for Meat Products using Information Index

	Uncompensated Own-price elasticity	Expenditure Elasticity	Information Elasticity
Frozen Seafood	-0.2312***	0.5887***	0.0020
Frozen poultry	-0.3623***	0.3663***	-0.0055
Frozen Beef	-0.8069***	0.7353***	-0.0010
Frozen Pork	-0.8368***	0.7781***	0.0063
Fresh Meat	-0.7850***	0.7845***	0.0087
Frozen Other	-1.2226***	3.7509***	-0.0142

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.3 : Compensated Own-Price and Cross-Price Elasticity for Meat Products using Information Index

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.1175*	-0.1343**	0.0370	0.0351	0.0842**	0.0956***
Frozen poultry	-0.1446**	-0.2967***	0.1827***	0.1478***	0.0291	0.0816***
Frozen Beef	0.0348	0.1597***	-0.6561***	0.1336***	0.1924***	0.1355***
Frozen Pork	0.0479	0.1877***	0.1941***	-0.7270***	0.2135***	0.0837***
Fresh Meat	0.0974**	0.0313	0.2365***	0.1806***	-0.6541***	0.1083***
Frozen Other	0.1613***	0.1279***	0.2431***	0.1033***	0.1580***	-0.7936***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.4 : Test of Nested Models for Meat Products using Positive and Negative Sentiment Indices

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	90.34	<.0001
CBS	λ=1, μ=0	55.71	<.0001
AIDS	λ=1, μ=1	18.17	0.0001
NBR	λ=0, μ=1	50.18	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.5 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Positive and Negative Sentiment Indices

	Uncompensated Own-price elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Frozen Seafood	-0.24***	0.58***	-0.04	0.07
Frozen poultry	-0.40***	0.32***	0.09	1.31***
Frozen Beef	-0.85***	0.75***	0.01	-0.68
Frozen Pork	-0.81***	0.80***	-0.06	-0.49
Fresh Meat	-0.78***	0.74***	-0.25**	0.57
Frozen Other	-1.2269	3.9738	0.3722	-1.0749

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.6 : Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Positive and Negative Sentiment Indices

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.13**	-0.11**	0.05	0.02	0.07**	0.09***
Frozen poultry	-0.12**	-0.34***	0.20***	0.14***	0.05	0.08***
Frozen Beef	0.05	0.17***	-0.70***	0.13***	0.20***	0.15***
Frozen Pork	0.03	0.17***	0.20***	-0.70***	0.21***	0.09***
Fresh Meat	0.08**	0.06	0.24***	0.18***	-0.66***	0.10***
Frozen Other	0.16***	0.12***	0.26***	0.11***	0.14***	-0.79***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.7 : Test of Nested Models for Meat Products using Net Sentiment Index in Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	80.43	<.0001
CBS	λ=1, μ=0	54.01	<.0001
AIDS	λ=1, μ=1	24.17	<.0001
NBR	λ=0, μ=1	47.33	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.8 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Net Sentiment Index in Pre-event Period

	Uncompensated Own-price elasticity	Expenditure Elasticity	Sentiment Elasticity
Frozen Seafood	-0.3521***	0.6609***	-0.0004
Frozen poultry	-0.5897***	0.6637***	0.0652
Frozen Beef	-0.9287***	0.7818***	-0.0053
Frozen Pork	-0.7780***	0.5027***	-0.0010
Fresh Meat	-0.7825***	0.6695***	0.1258
Frozen Other	-1.2573***	3.7545***	-0.2789

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.9 : Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Net Sentiment Index in Pre-event Period

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.2193***	-0.0473	0.1077**	0.0105	0.0576	0.0907***
Frozen poultry	-0.0445	-0.4478***	0.2570***	0.0849***	0.0594	0.0908***
Frozen Beef	0.1005**	0.2551***	-0.7603***	0.1046***	0.1612***	0.1390***
Frozen Pork	0.0191	0.1649***	0.2047***	-0.7226***	0.2658***	0.0681**
Fresh Meat	0.0754	0.0828	0.2262***	0.1906***	-0.6798***	0.1047***
Frozen Other	0.1717***	0.1829***	0.2820***	0.0706**	0.1514***	-0.8585***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.10 : Test of Nested Models for Meat Products using Net Sentiment Index in Post-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	51.61	<.0001
CBS	λ=1, μ=0	34.48	<.0001
AIDS	λ=1, μ=1	24.26	<.0001
NBR	λ=0, μ=1	39.83	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.11 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Net Sentiment Index in Post-event Period

	Uncompensated Elasticity	Expenditure Elasticity	Sentiment Elasticity
Frozen Seafood	0.0711	0.5791***	0.1537
Frozen poultry	-0.1785	0.6626***	0.0623
Frozen Beef	-0.7164***	1.0501***	0.2482
Frozen Pork	-0.4485***	0.1986	-0.0819
Fresh Meat	-0.4994***	0.7442***	-0.2426
Frozen Other	-1.0679***	3.3960***	-0.4117

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.12 : Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Net Sentiment Index in Post-event Period

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	0.1876	-0.1841	-0.0221	-0.0686	0.0031	0.0841*
Frozen poultry	-0.1805	-0.0425	0.1045	0.0983	-0.0418	0.0619
Frozen Beef	-0.0209	0.1007	-0.4927***	0.1119***	0.1644***	0.1366***
Frozen Pork	-0.1175	0.1717	0.2028***	-0.4251***	0.1325	0.0357
Fresh Meat	0.0042	-0.0579	0.2368***	0.1053	-0.3893**	0.1010**
Frozen Other	0.1473*	0.1105	0.2532***	0.0365	0.1300**	-0.6776*

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.13 : Test of Nested Models for Meat Products using Information Index in Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	79.03	<.0001
CBS	λ=1, μ=0	52.79	<.0001
AIDS	λ=1, μ=1	23.08	<.0001
NBR	λ=0, μ=1	45.9	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.14 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Information Index in Pre-event Period

	Uncompensated Own-price elasticity	Expenditure Elasticity	Information Elasticity
Frozen Seafood	-0.3639***	0.6671***	0.0039
Frozen poultry	-0.5845***	0.6632***	-0.0053
Frozen Beef	-0.9251***	0.7726***	-0.0055
Frozen Pork	-0.7533***	0.4997***	0.0022
Fresh Meat	-0.7924***	0.6620***	-0.0032
Frozen Other	-1.2527***	3.7762***	0.0204

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.15: Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Information Index in Pre-event Period

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.2298***	-0.0409	0.1025**	0.0126	0.0651*	0.0905***
Frozen poultry	-0.0385	-0.4427***	0.2581***	0.0773***	0.0549	0.0909***
Frozen Beef	0.0956**	0.2561***	-0.7587***	0.1001***	0.1692***	0.1377***
Frozen Pork	0.0230	0.1502***	0.1959***	-0.6983***	0.2626***	0.0666**
Fresh Meat	0.0852*	0.0765***	0.2375***	0.1883**	-0.6907***	0.1032***
Frozen Other	0.1713***	0.1829***	0.2793***	0.0690**	0.1491***	-0.8517***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.16 : Test of Nested Models for Meat Products using Information Index in Post-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	42.64	<.0001
CBS	λ=1, μ=0	28.75	<.0001
AIDS	λ=1, μ=1	19.51	<.0001
NBR	λ=0, μ=1	32.87	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.17 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Information Index in Post-event Period

	Uncompensated Own-price elasticity	Expenditure Elasticity	Information Elasticity
Frozen Seafood	-0.0448	0.6115***	-0.0020
Frozen poultry	-0.2796	0.6614***	-0.0037
Frozen Beef	-0.7375***	0.9878***	0.0045
Frozen Pork	-0.5050***	0.3142**	-0.0018
Fresh Meat	-0.5928***	0.7816***	-0.0084
Frozen Other	-1.1038**	3.2903***	0.0159

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.18 : Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Information Index in Post-event Period

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	0.0783	-0.1208	-0.0048	-0.0917	0.0651	0.0739
Frozen poultry	-0.1184	-0.1438	0.0928	0.1322*	-0.0363	0.0734
Frozen Beef	-0.0045	0.0894	-0.5271***	0.1303***	0.1688***	0.1431**
Frozen Pork	-0.1570	0.2309*	0.2362***	-0.4681***	0.1046	0.0534
Fresh Meat	0.0885	-0.0503	0.2431***	0.0831	-0.4772***	0.1128**
Frozen Other	0.1294	0.1312	0.2652**	0.0546	0.1452**	-0.7256*

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.19 : Test of Nested Models for Meat Products using Positive and Negative Sentiment Indices in Pre-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	80.89	<.0001
CBS	λ=1, μ=0	54.64	<.0001
AIDS	λ=1, μ=1	24.49	<.0001
NBR	λ=0, μ=1	47.43	<.0001

Table value of $\chi 2$ for 2 degrees of freedom is 5.991 at $\alpha = 0.05$

TableC.20 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Positive and Negative Sentiment Indices in Pre-event Period

	Uncompensated Own-price elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Frozen Seafood	-0.3700***	0.6628***	0.1186	0.2128
Frozen poultry	-0.5844***	0.6702***	0.0467	0.1668
Frozen Beef	-0.9136***	0.7785***	0.0904	-0.2573
Frozen Pork	-0.7747***	0.4993***	-0.0240	-0.1612
Fresh Meat	-0.7861***	0.6665***	-0.0282	-0.1894
Frozen Other	-1.2534***	3.7523***	-0.3941	0.2243

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.21 : Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Positive and Negative Sentiment Indices in Pre-event Period

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.2368***	-0.0464	0.1150**	0.0134	0.0672*	0.0877***
Frozen poultry	-0.0437	-0.4411***	0.2516***	0.0836***	0.0599	0.0897***
Frozen Beef	0.1072**	0.2497	-0.7459***	0.0981***	0.1504***	0.1405***
Frozen Pork	0.0245	0.1624***	0.1921***	-0.7198***	0.2728***	0.0680**
Fresh Meat	0.0880*	0.0834	0.2111***	0.1956***	-0.6838***	0.1057***
Frozen Other	0.1660***	0.1806***	0.2850***	0.0705**	0.1528***	-0.8549***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.22 : Test of Nested Models for Meat Products using Positive and Negative Sentiment Indices in Post-event Period

Model	Test	χ^2 Statistics	P-value
Rotterdam	λ=0, μ=0	67.05	<.0001
CBS	λ=1, μ=0	42.97	<.0001
AIDS	λ=1, μ=1	45.89	<.0001
NBR	λ=0, μ=1	69.68	<.0001

Table value of χ2 for 2 degrees of freedom is 5.991 at α = 0.05

Table C.23 : Uncompensated Own-Price, Expenditure and Sentiment Elasticity of Synthetic Model for Meat Products with Positive and Negative Sentiment Indices in Post-event Period

	Uncompensated Own-price elasticity	Expenditure Elasticity	Negative Sentiment Elasticity	Positive Sentiment Elasticity
Frozen Seafood	-0.2867**	0.8276***	0.4436***	-1.2541**
Frozen poultry	-0.7210***	0.3992***	-0.3000	1.6612***
Frozen Beef	-0.8100***	0.9880***	0.2094	-0.8642
Frozen Pork	-0.3841***	0.0662***	-0.0561	-0.4935**
Fresh Meat	-0.9538***	0.9842***	0.1734	-1.1461
Frozen Other	-1.2878***	3.3728	-0.7598	2.8111

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.24 : Compensated Own-Price and Cross-Price Elasticity of Synthetic Model for Meat Products with Positive and Negative Sentiment Indices in Post-event Period

	Frozen Seafood	Frozen poultry	Frozen Beef	Frozen Pork	Fresh Meat	Frozen Other
Frozen Seafood	-0.1201	0.0315	0.2086***	0.0268	-0.2628***	0.1161***
Frozen poultry	0.0308	-0.6390***	-0.0017	0.0121	0.5303***	0.0675*
Frozen Beef	0.1971***	-0.0016	-0.5996***	0.1047***	0.1152*	0.1842***
Frozen Pork	0.0458	0.0211	0.1897***	-0.3763***	0.1111	0.0085
Fresh Meat	-0.3575***	0.7358***	0.1659*	0.0883	-0.8082***	0.1757***
Frozen Other	0.2033***	0.1206*	0.3415***	0.0087	0.2262***	-0.9002***

* indicates statistical significance at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level, all elasticities are calculated at the sample mean

Table C.25: Parameter Estimates for Synthetic Model for Meat Products with Net Sentiment Index

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.3223	0.0709	-4.55	<.0001
b2	-0.3437	0.0727	-4.73	<.0001
b3	-0.3089	0.0721	-4.28	<.0001
b4	-0.2040	0.0397	-5.14	<.0001
b5	-0.2477	0.0523	-4.74	<.0001
b6[a]	0.1808	0.0561	3.22	0.0016
g11	0.1984	0.0397	5.00	<.0001
g12	-0.0707	0.0133	-5.32	<.0001
g13	-0.0469	0.0130	-3.60	0.0004
g14	-0.0349	0.0074	-4.75	<.0001
g15	-0.0325	0.0104	-3.12	0.0022
g16[a]	-0.0123	0.0056	-2.21	0.0289
g22	0.1522	0.0408	3.73	0.0003
g23	-0.0174	0.0131	-1.33	0.1848
g24	-0.0141	0.0082	-1.72	0.0876
g25	-0.0352	0.0112	-3.14	0.0020
g26[a]	-0.0131	0.0058	-2.25	0.0260
g33	0.0910	0.0400	2.27	0.0245
g34	-0.0137	0.0067	-2.04	0.0433
g35	-0.0093	0.0097	-0.96	0.3387
g36[a]	-0.0025	0.0063	-0.39	0.6996
g44	0.0758	0.0234	3.24	0.0015
g45	-0.0020	0.0064	-0.31	0.7593
g46[a]	-0.0102	0.0029	-3.48	0.0007
g55	0.0889	0.0316	2.82	0.0055
g66[a]	0.0463	0.0221	2.10	0.0376
ρ11	-0.5761	0.0856	-6.73	<.0001
ρ12	-0.1654	0.0867	-1.91	0.0584
ρ21	-0.5922	0.0713	-8.30	<.0001
ρ22	-0.4434	0.0705	-6.29	<.0001
ρ31	-0.6568	0.0788	-8.34	<.0001
ρ32	-0.3148	0.0787	-4.00	<.0001
ρ41	-0.5336	0.0751	-7.11	<.0001
ρ42	-0.2871	0.0736	-3.90	0.0001
ρ51	-0.4232	0.0727	-5.82	<.0001
ρ52	-0.2504	0.0740	-3.38	0.0009
λ	2.2506	0.3410	6.60	<.0001
μ	1.4363	0.2334	6.15	<.0001
z1	0.0001	0.0267	0.00	0.9968
y1	0.0037	0.0262	0.14	0.8882
z2	-0.0263	0.0270	-0.98	0.3310
y2	0.0513	0.0261	1.96	0.0516
z3	0.0222	0.0321	0.69	0.4904

Table C.25: Parameter Estimates for Synthetic Model for Meat Products with Net Sentiment Index

Parameter	Estimate	Std. Error	t-value	P-value
y3	-0.0220	0.0309	-0.71	0.4769
z4	-0.0062	0.0130	-0.48	0.6330
y4	-0.0142	0.0126	-1.12	0.2633
z5	0.0095	0.0230	0.41	0.6816
y5	-0.0323	0.0221	-1.46	0.1466
z6[a]	0.0010	0.0654	0.02	0.9873
y6[a]	0.0198	0.0633	0.31	0.7547
$R^2$1	0.3211			
$R^2$2	0.5489			
$R^2$3	0.7526			
$R^2$4	0.4652			
$R^2$5	0.5681			
DW1	2.11			
DW2	2.15			
DW3	2.01			
DW4	2.13			
DW5	2.04			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Frozen Seafood, 2 is Frozen Poultry, 3 is Frozen Beef, 4 is Frozen Pork, 5 is Fresh Meat and 6 is Frozen Other meat.

[a] The parameter estimate is computed from adding-up restriction. P is the AR term for the respective equation and order, z and y are the cofficents for no lag and first lag of sentiment index

Table C.26 : Parameter Estimates for Synthetic Model for Meat Products with Separate Sentiment Indices

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.3185	0.0699	-4.55	<.0001
b2	-0.3412	0.0717	-4.76	<.0001
b3	-0.3033	0.0711	-4.26	<.0001
b4	-0.2017	0.0391	-5.16	<.0001
b5	-0.2486	0.0516	-4.82	<.0001
b6[a]	0.1952	0.0562	3.47	0.0007
g11	0.1789	0.0397	4.50	<.0001
g12	-0.0710	0.0133	-5.35	<.0001
g13	-0.0462	0.0130	-3.55	0.0005
g14	-0.0341	0.0073	-4.68	<.0001
g15	-0.0319	0.0104	-3.07	0.0026
g16[a]	-0.0117	0.0056	-2.10	0.0376
g22	0.1482	0.0408	3.63	0.0004
g23	-0.0171	0.0130	-1.31	0.1911
g24	-0.0118	0.0081	-1.46	0.1475
g25	-0.0332	0.0112	-2.96	0.0036
g26[a]	-0.0128	0.0058	-2.20	0.0295
g33	0.0884	0.0400	2.21	0.0287
g34	-0.0136	0.0067	-2.04	0.0437
g35	-0.0082	0.0097	-0.85	0.3979
g36[a]	-0.0017	0.0064	-0.26	0.7932
g44	0.0742	0.0233	3.18	0.0018
g45	-0.0038	0.0063	-0.59	0.5543
g46[a]	-0.0098	0.0029	-3.33	0.0011
g55	0.0879	0.0316	2.78	0.0061
g66[a]	0.0442	0.0221	2.00	0.0474
ρ11	-0.5715	0.0862	-6.63	<.0001
ρ12	-0.1575	0.0873	-1.80	0.0735
ρ21	-0.5646	0.0715	-7.90	<.0001
ρ22	-0.4477	0.0705	-6.35	<.0001
ρ31	-0.6647	0.0786	-8.46	<.0001
ρ32	-0.3267	0.0789	-4.14	<.0001
ρ41	-0.5362	0.0748	-7.17	<.0001
ρ42	-0.2896	0.0730	-3.97	0.0001
ρ51	-0.3706	0.0725	-5.11	<.0001
ρ52	-0.2918	0.0731	-3.99	0.0001
λ	2.2268	0.3361	6.63	<.0001
μ	1.4245	0.2333	6.11	<.0001
z1	-0.0007	0.0304	-0.02	0.9806
y1	-0.0074	0.0232	-0.32	0.7488
x1	0.0142	0.0969	0.15	0.8834
z2	-0.0557	0.0303	-1.84	0.0679

Table C.26 : Parameter Estimates for Synthetic Model for Meat Products with Separate Sentiment Indices

Parameter	Estimate	Std. Error	t-value	P-value
y2	0.0253	0.0225	1.13	0.2616
x2	0.2349	0.0879	2.67	0.0084
z3	0.0367	0.0360	1.02	0.3095
y3	-0.0048	0.0272	-0.18	0.8606
x3	-0.1385	0.1135	-1.22	0.2244
z4	0.0029	0.0145	0.20	0.8421
y4	-0.0095	0.0109	-0.87	0.3871
x4	-0.0698	0.0432	-1.62	0.1083
z5	-0.0072	0.0257	-0.28	0.7794
y5	-0.0397	0.0192	-2.08	0.0397
x5	0.0947	0.0702	1.35	0.1796
z6[a]	0.0224	0.0741	0.30	0.7630
y6[a]	0.0400	0.0555	0.72	0.4722
x6[a]	-0.1229	0.2167	-0.57	0.5714
$R^2$1	0.3216			
$R^2$2	0.5631			
$R^2$3	0.7539			
$R^2$4	0.4805			
$R^2$5	0.5759			
DW1	2.11			
DW2	2.14			
DW3	2.01			
DW4	2.16			
DW5	2.05			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Frozen Seafood, 2 is Frozen Poultry, 3 is Frozen Beef, 4 is Frozen Pork, 5 is Fresh Meat and 6 is Frozen Other meat.

[a] The parameter estimate is computed from adding-up restriction. P is the AR term for the respective equation and order, z and y are the coefficients for no lag and first lag of negative sentiment index, x is coefficient of positive sentiment index

Table C. 27: Parameter Estimates for Synthetic Model for Meat Products with Information Index

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.2965	0.0754	-3.93	0.0001
b2	-0.3152	0.0778	-4.05	<.0001
b3	-0.2849	0.0775	-3.67	0.0003
b4	-0.1900	0.0423	-4.49	<.0001
b5	-0.2236	0.0557	-4.01	<.0001
b6[a]	0.1895	0.0566	3.35	0.0010
g11	0.2016	0.0404	4.99	<.0001
g12	-0.0758	0.0143	-5.29	<.0001
g13	-0.0499	0.0133	-3.76	0.0002
g14	-0.0325	0.0076	-4.30	<.0001
g15	-0.0301	0.0107	-2.81	0.0056
g16[a]	-0.0129	0.0056	-2.31	0.0221
g22	0.1587	0.0419	3.79	0.0002
g23	-0.0202	0.0137	-1.48	0.1420
g24	-0.0099	0.0085	-1.17	0.2437
g25	-0.0379	0.0116	-3.26	0.0014
g26[a]	-0.0143	0.0060	-2.38	0.0185
g33	0.1001	0.0407	2.46	0.0150
g34	-0.0143	0.0069	-2.07	0.0401
g35	-0.0098	0.0098	-1.00	0.3187
g36[a]	-0.0056	0.0064	-0.88	0.3798
g44	0.0719	0.0238	3.03	0.0029
g45	-0.0038	0.0065	-0.58	0.5630
g46[a]	-0.0110	0.0030	-3.73	0.0003
g55	0.0910	0.0319	2.85	0.0050
g66[a]	0.0522	0.0222	2.35	0.0202
z1	0.0019	0.0022	0.86	0.3925
z2	0.0022	0.0025	0.87	0.3839
z3	-0.0024	0.0027	-0.88	0.3796
z4	-0.0018	0.0011	-1.57	0.1193
z5	-0.0021	0.0020	-1.07	0.2875
z6[a]	0.0024	0.0056	0.43	0.6670
y1	0.0000	0.0015	0.01	0.9922
y2	-0.0014	0.0017	-0.82	0.4115
y3	0.0003	0.0018	0.16	0.8715
y4	0.0011	0.0007	1.53	0.1270
y5	0.0018	0.0013	1.41	0.1605
y6[a]	-0.0020	0.0037	-0.54	0.5918
λ	2.1241	0.3641	5.83	<.0001
μ	1.4396	0.2354	6.12	<.0001
ρ1	-0.5080	0.0749	-6.79	<.0001
ρ2	-0.4290	0.0727	-5.90	<.0001
ρ3	-0.4864	0.0695	-7.00	<.0001

Table C. 27: Parameter Estimates for Synthetic Model for Meat Products with Information Index

Parameter	Estimate	Std. Error	t-value	P-value
ρ4	-0.4044	0.0710	-5.69	<.0001
ρ5	-0.3428	0.0708	-4.84	<.0001
$R^2$1	0.3082			
$R^2$2	0.4378			
$R^2$3	0.7306			
$R^2$4	0.4256			
$R^2$5	0.5445			
DW1	2.16			
DW2	2.30			
DW3	2.27			
DW4	2.26			
DW5	2.09			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z and y are the coefficients for no lag and first lag of information index.

Table C28: Parameter Estimates of Synthetic Model for Meat Products with Net Sentiment Index in Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.4870	0.1053	-4.63	<.0001
b2	-0.5175	0.1086	-4.76	<.0001
b3	-0.4961	0.1054	-4.71	<.0001
b4	-0.2842	0.0555	-5.12	<.0001
b5	-0.3707	0.0767	-4.83	<.0001
b6 [a]	0.0690	0.0749	0.92	0.3589
g11	0.1942	0.0503	3.86	0.0002
g12	-0.0732	0.0162	-4.51	<.0001
g13	-0.0426	0.0159	-2.68	0.0085
g14	-0.0307	0.0084	-3.65	0.0004
g15	-0.0342	0.0125	-2.73	0.0073
g16 [a]	-0.0106	0.0067	-1.57	0.1183
g22	0.1536	0.0520	2.96	0.0038
g23	-0.0134	0.0163	-0.82	0.4144
g24	-0.0168	0.0095	-1.77	0.0788
g25	-0.0360	0.0131	-2.75	0.0069
g26 [a]	-0.0111	0.0073	-1.53	0.1300
g33	0.0870	0.0516	1.69	0.0946
g34	-0.0127	0.0084	-1.50	0.1362
g35	-0.0143	0.0120	-1.20	0.2330
g36 [a]	-0.0012	0.0078	-0.16	0.8743
g44	0.0658	0.0296	2.22	0.0284
g45	0.0042	0.0072	0.58	0.5634
g46 [a]	-0.0081	0.0037	-2.19	0.0305
g55	0.0884	0.0402	2.20	0.0298
g66 [a]	0.0363	0.0278	1.30	0.1951
z1	-0.0195	0.0180	-1.09	0.2797
z2	0.0167	0.0177	0.94	0.3469
z3	0.0108	0.0210	0.51	0.6088
z4	-0.0008	0.0089	-0.09	0.9260
z5	0.0248	0.0147	1.69	0.0934
z6 [a]	-0.0256	0.0428	-0.60	0.5518
y1	0.0038	0.0179	0.21	0.8307
y2	0.0104	0.0176	0.59	0.5572
y3	-0.0035	0.0207	-0.17	0.8675
y4	0.0000	0.0088	0.00	0.9979
y5	0.0155	0.0148	1.05	0.2971
y6 [a]	-0.0281	0.0430	-0.65	0.5146
λ	3.0842	0.5031	6.13	<.0001
μ	1.4836	0.3002	4.94	<.0001
ρ11	-0.5750	0.0997	-5.77	<.0001
ρ12	-0.1148	0.0988	-1.16	0.2477
ρ13	-0.6147	0.0805	-7.64	<.0001

Table C28: Parameter Estimates of Synthetic Model for Meat Products with Net Sentiment Index in Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
ρ14	-0.4629	0.0795	-5.82	<.0001
ρ15	-0.7265	0.0841	-8.64	<.0001
ρ21	-0.4125	0.0862	-4.79	<.0001
ρ22	-0.5890	0.0766	-7.69	<.0001
ρ23	-0.3178	0.0751	-4.23	<.0001
ρ24	-0.4010	0.0805	-4.98	<.0001
ρ25	-0.2765	0.0808	-3.42	0.0009
$R^2$1	0.3275			
$R^2$2	0.5787			
$R^2$3	0.7571			
$R^2$4	0.4760			
$R^2$5	0.6237			
DW1	2.06			
DW2	2.10			
DW3	2.00			
DW4	2.21			
DW5	1.95			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation, z and y are the coefficients for no lag and first lag of net sentiment index.

Table C.29: Parameter Estimates of Synthetic Model for Meat Products with Net Sentiment Index in Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.8089	0.1488	-5.44	<.0001
b2	-0.8079	0.1534	-5.27	<.0001
b3	-0.7559	0.1568	-4.82	<.0001
b4	-0.5172	0.0928	-5.58	<.0001
b5	-0.5702	0.1117	-5.11	<.0001
b6 [a]	-0.0616	0.1043	-0.59	0.5595
g11	0.1714	0.0739	2.32	0.0282
g12	-0.0714	0.0326	-2.19	0.0372
g13	-0.0401	0.0257	-1.56	0.1306
g14	-0.0335	0.0166	-2.02	0.0536
g15	-0.0241	0.0214	-1.13	0.2703
g16 [a]	-0.0031	0.0104	-0.30	0.7681
g22	0.1269	0.0724	1.75	0.0909
g23	-0.0149	0.0232	-0.64	0.5267
g24	0.0001	0.0167	0.01	0.9942
g25	-0.0338	0.0241	-1.40	0.1721
g26 [a]	-0.0054	0.0104	-0.52	0.6044
g33	0.0344	0.0648	0.53	0.5998
g34	0.0030	0.0117	0.26	0.7980
g35	0.0088	0.0160	0.55	0.5860
g36	0.0113	0.0113	1.00	0.3259
g44	0.0362	0.0408	0.89	0.3827
g45	0.0011	0.0136	0.08	0.9353
g46 [a]	-0.0073	0.0047	-1.54	0.1347
g55	0.0472	0.0558	0.85	0.4052
g66 [a]	0.0053	0.0384	0.14	0.8902
z1	0.0375	0.0344	1.09	0.2859
z2	-0.0167	0.0341	-0.49	0.6285
z3	0.0240	0.0342	0.70	0.4892
z4	-0.0107	0.0139	-0.77	0.4489
z5	-0.0184	0.0232	-0.79	0.4348
z6 [a]	-0.0227	0.0748	-0.30	0.7641
y1	-0.0136	0.0301	-0.45	0.6541
y2	0.0424	0.0297	1.43	0.1640
y3	-0.0206	0.0314	-0.66	0.5176
y4	-0.0124	0.0119	-1.04	0.3068
y5	-0.0087	0.0196	-0.44	0.6599
y6 [a]	0.0297	0.0659	0.45	0.6555
x1	0.0261	0.0338	0.77	0.4460
x2	0.0075	0.0328	0.23	0.8208

Table C.29: Parameter Estimates of Synthetic Model for Meat Products with Net Sentiment Index in Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
x3	0.0522	0.0321	1.62	0.1161
x4	-0.0069	0.0126	-0.55	0.5876
x5	-0.0319	0.0225	-1.42	0.1682
x6 [a]	-0.0558	0.0705	-0.79	0.4352
λ	4.5983	0.7363	6.24	<.0001
μ	0.8312	0.3876	2.14	0.0411
ρ1	-0.7436	0.1780	-4.18	0.0003
ρ2	-0.4044	0.1666	-2.43	0.0222
ρ3	-0.1964	0.1780	-1.10	0.2796
ρ4	-0.2254	0.2245	-1.00	0.3243
ρ5	-0.7787	0.1306	-5.96	<.0001
$R^2$1	0.3790			
$R^2$2	0.4774			
$R^2$3	0.8356			
$R^2$4	0.5444			
$R^2$5	0.6317			
DW1	2.11			
DW2	2.28			
DW3	2.20			
DW4	2.13			
DW5	2.20			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of net sentiment index.

Table C.30: Parameter Estimates of Synthetic Model for Meat Products with Information Index in Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.4761	0.1052	-4.53	<.0001
b2	-0.5073	0.1088	-4.66	<.0001
b3	-0.4877	0.1058	-4.61	<.0001
b4	-0.2792	0.0556	-5.02	<.0001
b5	-0.3644	0.0771	-4.73	<.0001
b6	0.0737	0.0741	0.99	0.3222
g11	0.1882	0.0503	3.74	0.0003
g12	-0.0709	0.0162	-4.38	<.0001
g13	-0.0426	0.0159	-2.69	0.0084
g14	-0.0298	0.0084	-3.55	0.0006
g15	-0.0320	0.0126	-2.54	0.0125
g16 [a]	-0.0098	0.0067	-1.45	0.1493
g22	0.1507	0.0517	2.91	0.0043
g23	-0.0121	0.0162	-0.74	0.4587
g24	-0.0178	0.0094	-1.90	0.0606
g25	-0.0362	0.0130	-2.77	0.0065
g26 [a]	-0.0105	0.0072	-1.46	0.1470
g33	0.0833	0.0514	1.62	0.1082
g34	-0.0131	0.0084	-1.56	0.1227
g35	-0.0118	0.0120	-0.99	0.3255
g36 [a]	-0.0008	0.0077	-0.10	0.9199
g44	0.0661	0.0295	2.24	0.0271
g45	0.0042	0.0072	0.59	0.5580
g46 [a]	-0.0079	0.0037	-2.14	0.0343
g55	0.0836	0.0401	2.09	0.0393
g66 [a]	0.0337	0.0278	1.21	0.2287
z1	-0.0007	0.0014	-0.50	0.6210
z2	0.0024	0.0013	1.87	0.0638
z3	0.0007	0.0015	0.50	0.6152
z4	0.0000	0.0007	0.02	0.9848
z5	0.0019	0.0012	1.60	0.1127
z6 [a]	-0.0043	0.0033	-1.31	0.1924
y1	0.0009	0.0010	0.89	0.3728
y2	-0.0017	0.0010	-1.58	0.1167
y3	-0.0014	0.0012	-1.11	0.2682
y4	0.0002	0.0005	0.46	0.6455
y5	-0.0008	0.0009	-0.92	0.3585
y6 [a]	0.0029	0.0025	1.18	0.2398
λ	3.0361	0.5036	6.03	<.0001
μ	1.4597	0.2994	4.88	<.0001
ρ11	-0.5501	0.1009	-5.45	<.0001
ρ12	-0.0899	0.0990	-0.91	0.3654
ρ13	-0.6315	0.0810	-7.79	<.0001

Table C.30: Parameter Estimates of Synthetic Model for Meat Products with Information Index in Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
ρ14	-0.4559	0.0795	-5.73	<.0001
ρ15	-0.7237	0.0853	-8.49	<.0001
ρ21	-0.3955	0.0859	-4.60	<.0001
ρ22	-0.5714	0.0771	-7.41	<.0001
ρ23	-0.3148	0.0757	-4.16	<.0001
ρ24	-0.3936	0.0802	-4.91	<.0001
ρ25	-0.2749	0.0804	-3.42	0.0009
$R^2$1	0.3255			
$R^2$2	0.5862			
$R^2$3	0.7584			
$R^2$4	0.4859			
$R^2$5	0.6163			
DW1	2.05			
DW2	2.09			
DW3	1.98			
DW4	2.22			
DW5	1.96			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.
[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation z and y are the coefficients for no lag and first lag of information index.

Table C.31: Parameter Estimates of Synthetic Model for Meat Products with Information Index in Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.7347	0.1535	-4.79	<.0001
b2	-0.7392	0.1572	-4.70	<.0001
b3	-0.6976	0.1610	-4.33	0.0002
b4	-0.4641	0.0957	-4.85	<.0001
b5	-0.5149	0.1145	-4.50	0.0001
b6	-0.1411	0.1065	-1.32	0.1966
g11	0.2193	0.0843	2.60	0.0149
g12	-0.0766	0.0359	-2.13	0.0421
g13	-0.0552	0.0292	-1.89	0.0692
g14	-0.0484	0.0176	-2.76	0.0103
g15	-0.0246	0.0234	-1.05	0.3031
g16 [a]	-0.0130	0.0112	-1.16	0.2556
g22	0.1770	0.0831	2.13	0.0425
g23	-0.0363	0.0258	-1.41	0.1702
g24	-0.0034	0.0190	-0.18	0.8590
g25	-0.0459	0.0270	-1.70	0.1001
g26 [a]	-0.0080	0.0103	-0.78	0.4402
g33	0.1000	0.0760	1.31	0.1997
g34	-0.0039	0.0133	-0.30	0.7689
g35	-0.0039	0.0181	-0.22	0.8292
g36 [a]	0.0038	0.0117	0.32	0.7485
g44	0.0763	0.0472	1.62	0.1173
g45	-0.0097	0.0148	-0.66	0.5176
g46 [a]	-0.0104	0.0050	-2.08	0.0475
g55	0.0890	0.0621	1.43	0.1633
g66 [a]	0.0314	0.0394	0.80	0.4313
z1	0.0002	0.0037	0.07	0.9484
z2	0.0012	0.0038	0.32	0.7531
z3	0.0018	0.0039	0.46	0.6472
z4	-0.0014	0.0016	-0.89	0.3835
z5	-0.0027	0.0022	-1.23	0.2306
z6 [a]	-0.0001	0.0078	-0.01	0.9945
y1	0.0019	0.0046	0.42	0.6801
y2	0.0001	0.0047	0.01	0.9885
y3	-0.0031	0.0047	-0.66	0.5159
y4	0.0012	0.0019	0.64	0.5300
y5	0.0036	0.0028	1.28	0.2126
y6 [a]	-0.0026	0.0092	-0.28	0.7845
x1	-0.0008	0.0022	-0.39	0.7023
x2	-0.0010	0.0020	-0.50	0.6203
x3	0.0012	0.0021	0.60	0.5541

Table C.31: Parameter Estimates of Synthetic Model for Meat Products with Information Index in Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
x4	-0.0002	0.0008	-0.23	0.8228
x5	-0.0014	0.0014	-0.99	0.3291
x6 [a]	0.0013	0.0042	0.30	0.7674
λ	4.2623	0.7573	5.63	<.0001
μ	1.2660	0.4528	2.80	0.0094
ρ1	-0.5413	0.1923	-2.81	0.0090
ρ2	-0.3649	0.1681	-2.17	0.0389
ρ3	-0.4059	0.1755	-2.31	0.0286
ρ4	-0.3196	0.2224	-1.44	0.1622
ρ5	-0.7258	0.1373	-5.28	<.0001
$R^2$1	0.3699			
$R^2$2	0.4772			
$R^2$3	0.8294			
$R^2$4	0.5224			
$R^2$5	0.6492			
DW1	2.18			
DW2	2.31			
DW3	2.09			
DW4	2.09			
DW5	2.26			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of information index.

Table C.32: Parameter Estimates of Synthetic Model for Meat Products with Separate Sentiment Indices in Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.4875	0.1064	-4.58	<.0001
b2	-0.5171	0.1098	-4.71	<.0001
b3	-0.4978	0.1066	-4.67	<.0001
b4	-0.2851	0.0561	-5.08	<.0001
b5	-0.3718	0.0776	-4.79	<.0001
b6	0.0682	0.0757	0.90	0.3691
g11	0.1956	0.0510	3.84	0.0002
g12	-0.0744	0.0165	-4.51	<.0001
g13	-0.0425	0.0161	-2.63	0.0097
g14	-0.0308	0.0086	-3.60	0.0005
g15	-0.0332	0.0127	-2.61	0.0105
g16 [a]	-0.0116	0.0068	-1.69	0.0936
g22	0.1602	0.0527	3.04	0.0030
g23	-0.0160	0.0166	-0.96	0.3381
g24	-0.0178	0.0096	-1.85	0.0668
g25	-0.0369	0.0134	-2.75	0.0071
g26 [a]	-0.0118	0.0074	-1.60	0.1130
g33	0.0953	0.0523	1.82	0.0715
g34	-0.0148	0.0086	-1.72	0.0879
g35	-0.0177	0.0122	-1.45	0.1503
g36 [a]	-0.0014	0.0079	-0.18	0.8611
g44	0.0691	0.0300	2.31	0.0230
g45	0.0044	0.0074	0.60	0.5479
g46 [a]	-0.0084	0.0038	-2.22	0.0282
g55	0.0918	0.0408	2.25	0.0266
g66 [a]	0.0386	0.0284	1.36	0.1764
z1	-0.0043	0.0206	-0.21	0.8360
z2	0.0265	0.0198	1.33	0.1848
z3	0.0016	0.0238	0.07	0.9459
z4	-0.0016	0.0100	-0.16	0.8714
z5	0.0240	0.0162	1.48	0.1421
z6 [a]	-0.0317	0.0480	-0.66	0.5110
y1	-0.0135	0.0208	-0.65	0.5199
y2	0.0061	0.0212	0.29	0.7744
y3	0.0059	0.0259	0.23	0.8208
y4	-0.0023	0.0105	-0.21	0.8304
y5	0.0148	0.0168	0.88	0.3794
y6 [a]	-0.0209	0.0507	-0.41	0.6805
x1	0.0274	0.0207	1.33	0.1879
x2	0.0030	0.0197	0.15	0.8780
x3	0.0179	0.0233	0.77	0.4454
x4	-0.0022	0.0098	-0.23	0.8223
x5	-0.0103	0.0160	-0.64	0.5225

Table C.32: Parameter Estimates of Synthetic Model for Meat Products with Separate Sentiment Indices in Pre-event Period

Parameter	Estimate	Std. Error	t-value	P-value
x6 [a]	-0.0291	0.0474	-0.61	0.5403
v1	0.0428	0.0607	0.70	0.4827
v2	0.0357	0.0600	0.59	0.5537
v3	-0.0554	0.0710	-0.78	0.4363
v4	-0.0177	0.0298	-0.59	0.5535
v5	-0.0291	0.0467	-0.62	0.5353
v6 [a]	0.0225	0.1445	0.16	0.8766
λ	3.0888	0.5085	6.07	<.0001
μ	1.5144	0.3042	4.98	<.0001
ρ11	-0.5688	0.1010	-5.63	<.0001
ρ12	-0.0959	0.0998	-0.96	0.3386
ρ13	-0.5924	0.0829	-7.15	<.0001
ρ14	-0.4518	0.0816	-5.54	<.0001
ρ15	-0.7388	0.0854	-8.65	<.0001
ρ21	-0.4083	0.0875	-4.67	<.0001
ρ22	-0.5906	0.0776	-7.61	<.0001
ρ23	-0.3165	0.0762	-4.15	<.0001
ρ24	-0.4048	0.0822	-4.93	<.0001
ρ25	-0.2669	0.0828	-3.22	0.0017
$R^2$1	0.3344			
$R^2$2	0.5778			
$R^2$3	0.7601			
$R^2$4	0.4780			
$R^2$5	0.6254			
DW1	2.06			
DW2	2.08			
DW3	1.95			
DW4	2.22			
DW5	1.95			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 and AR2 term for the respective equation z, y and x are the coefficients for no lag, first lag and second lag of negative sentiment index and v is coefficient for the no lag of positive sentiment index.

Table C.33: Parameter Estimates of Synthetic Model for Meat Products with Separate Sentiment Indices in Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
b1	-0.8245	0.1219	-6.76	<.0001
b2	-0.9289	0.1257	-7.39	<.0001
b3	-0.8386	0.1315	-6.38	<.0001
b4	-0.5711	0.0744	-7.67	<.0001
b5	-0.5829	0.0953	-6.11	<.0001
b6	-0.1000	0.1018	-0.98	0.3348
g11	0.0232	0.0630	0.37	0.7157
g12	-0.0058	0.0241	-0.24	0.8105
g13	0.0294	0.0168	1.75	0.0919
g14	-0.0016	0.0136	-0.12	0.9081
g15	-0.0617	0.0196	-3.14	0.0041
g16	-0.0051	0.0113	-0.45	0.6542
g22	-0.0831	0.0597	-1.39	0.1758
g23	-0.0132	0.0190	-0.70	0.4923
g24	-0.0046	0.0123	-0.38	0.7098
g25	0.0999	0.0175	5.72	<.0001
g26	-0.0062	0.0087	-0.71	0.4866
g33	-0.0783	0.0539	-1.45	0.1585
g34	0.0149	0.0101	1.48	0.1515
g35	0.0153	0.0160	0.95	0.3484
g36	0.0150	0.0115	1.31	0.2006
g44	-0.0137	0.0346	-0.40	0.6961
g45	0.0079	0.0122	0.65	0.5204
g46	-0.0072	0.0048	-1.50	0.1466
g55	-0.0824	0.0508	-1.62	0.1170
g66	-0.0005	0.0388	-0.01	0.9906
z1	0.0977	0.0350	2.79	0.0097
z2	-0.1101	0.0295	-3.73	0.0009
z3	0.0546	0.0403	1.35	0.1871
z4	0.0051	0.0134	0.38	0.7079
z5	0.0363	0.0360	1.01	0.3221
z6 [a]	-0.0684	0.0848	-0.81	0.4272
y1	-0.0276	0.0263	-1.05	0.3044
y2	0.0142	0.0317	0.45	0.6575
y3	0.0018	0.0285	0.06	0.9507
y4	-0.0077	0.0114	-0.67	0.5065
y5	-0.0023	0.0246	-0.09	0.9275
y6 [a]	0.0114	0.0591	0.19	0.8489
x1	0.0752	0.0244	3.08	0.0049
x2	-0.0419	0.0232	-1.81	0.0820
x3	0.0326	0.0274	1.19	0.2452
x4	-0.0063	0.0099	-0.63	0.5313
x5	0.0206	0.0264	0.78	0.4425

Table C.33: Parameter Estimates of Synthetic Model for Meat Products with Separate Sentiment Indices in Post-event Period

Parameter	Estimate	Std. Error	t-value	P-value
x6 [a]	-0.0573	0.0606	-0.95	0.3527
v1	-0.2524	0.0916	-2.76	0.0106
v2	0.3410	0.0462	7.38	<.0001
v3	-0.1841	0.1131	-1.63	0.1156
v4	-0.0580	0.0268	-2.16	0.0401
v5	-0.1696	0.1074	-1.58	0.1264
v6 [a]	0.2428	0.2440	1.00	0.3287
λ	4.9243	0.6075	8.11	<.0001
μ	0.2947	0.3176	0.93	0.3620
ρ1	-0.9930	0.1207	-8.23	<.0001
ρ2	0.3879	0.1235	3.14	0.0042
ρ3	-0.4384	0.1547	-2.83	0.0088
ρ4	0.2150	0.1940	1.11	0.2779
ρ5	-0.6563	0.1253	-5.24	<.0001
$R^2$1	0.2231			
$R^2$2	0.3858			
$R^2$3	0.8119			
$R^2$4	0.5696			
$R^2$5	0.2993			
DW1	1.91			
DW2	2.24			
DW3	2.11			
DW4	2.16			
DW5	2.31			

The Durbin-Watson statistic DW and R^2 are computed for each single equation. The category 1 is Peanut Butter, 2 is Jelly, 3 is Marmalade, 4 is Preserves and 5 is Jam.

[a] The parameter estimate is computed from adding-up restriction. ρ is the AR1 term for the respective equation, z, y and x are the coefficients for no lag, first lag and second lag of negative sentiment index and v is coefficient for the no lag of positive sentiment index.

VITA

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