# IMPACT OF NUTRITION INFORMATION ON CONSUMERS' FOOD PURCHASES

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

SAKIKO SHIRATORI

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

PROFESSOR JEAN KINSEY, CO-ADVISER
PROFESSOR PAUL GLEWWE, CO-ADVISER

AUGUST 2011

## Acknowledgements

I am deeply grateful to Professor Jean Kinsey, my adviser and also my supervisor for the research assistant, for her advice, mentorship, and encouragement throughout my PhD program. She has always been there for me out of her extremely busy schedule, and even after her retirement. I would also like to thank my co-adviser Professor Paul Glewwe for his guidance, support, and kindness. I benefited greatly from his comments, which were full of important insights.

My sincere appreciation goes to my thesis committee members, Professors Timothy Beatty, David Fan, and John Finnegan for their assistance. In addition, many people provided help at various stages. I learned a lot from Professor Benjamin Senauer in working with him. Without Professor Donald Liu, I would not have been in this program. My thanks also go to staff in our department: Lisa Jore, Elaine Reber, Louise Letnes, Linda Schwartz, Phay Vang, to name a few.

I feel I am fortunate to have a financial support through the Graduate School Fellowship and the Department of Applied Economics. The USDA-ERS enabled me to carry out my dissertation by letting me use the ACNielsen Homescan® data. Additionally, Professor Fan kindly let me use the InfoTrend® software he developed.

Thanks to the dissertation writing group members: Eugenie, Misty, Uttam, David for keeping my motivation. Thanks to Wonho and Jin-Young for innumerable study sessions. Nice to have Japanese colleges: Shinya, Tetsuya, Kenji, Yoshi, Michi, and Rocky. Andy, Haochi, Qihui, and many others, I appreciate the friendship and the time we spent together. Thanks to Shama Dahal for babysitting my daughter.

Finally, I would like to express deep gratitude to my family. Very special thanks to my husband, Mitsuru, for his love and understanding (and sometimes mathematical help). I would not have performed well without his constant support. Also special thanks to Sayuki for being my daughter. Moreover, I thank my parents, Fumio and Ikuko. They have been supportive all the time. I am glad to complete my PhD with all of these people and under the big, beautiful blue sky in Minnesota.

## Dedication

To Mitsuru and Sayuki

## Abstract

This study estimates the impact of nutrition information provided by popular media on consumers' purchases in U.S. grocery stores, taking omega-3 fortified eggs as an example. The media index which conveys the message about the health benefits of omega-3 fatty acids is constructed from multiple information sources by utilizing computer-coded content analysis. The probability of purchasing omega-3 eggs between 1998 and 2007 based on household-level scanner data is analyzed by logistic regression models (and probit, multinomial logit regression for comparison) to incorporate elements of information effects. In addition, the welfare change of consumers is measured by the consumer surplus and the value of information is also estimated.

The results show a significant positive impact of nutritional information from the popular media on consumers' food choices. Consumers are quite sensitive to the prices of regular eggs, but are not very sensitive to a change in the price of omega-3 eggs. Even though functional foods such as omega-3 eggs are sold at a higher price, consumers choose them perhaps for their health benefits. Regarding the welfare analysis, consumer surplus increased over this period. When the welfare change is investigated further using the concept of the value of information, most of the welfare change is accounted for by the information. In this way, publishing in popular media can be an effective information communication approach to promote consumers' health.

## Table of Contents

## List of Tables

**List of Figures**

## List of Acronyms

| | |
|---|---|
| AA: | Arachidonic Acids |
| AHA: | American Heart Association |
| AIDS: | Almost Ideal Demand System |
| ALA: | Alpha-Linolenic Acid |
| BLP: | Berry, Levinsohn and Pakes |
| BLS: | Bureau of Labor Statistics |
| BSE: | Bovine Spongiform Encephalopathy |
| CHD: | Coronary Heart Disease |
| COI: | Cost of Ignorance |
| CPI: | Consumer Price Index |
| CpS: | Compensating Surplus |
| CS: | Consumer Surplus |
| CV: | Compensating Variation |
| DHA: | DocosaHexaenoic Acid |
| EFAs: | Essential Fatty Acids |
| EPA: | EicosaPentaenoic Acid |
| ERS: | Economic Research Service |
| FDA: | U.S. Food and Drug Administration |
| FMI: | Food Marketing Institute |
| GLA: | Gamma-Linolenic Acid |
| HHS: | The U.S. Department of Health and Human Services |
| HH(s): | Households |
| IFIC: | International Food Information Council Foundation |
| IFT: | Institute of Food Technologists |
| IIA: | Independence from Irrelevant Alternatives |
| *iid*: | independent and identically distributed |
| LA: | Linoleic Fatty Acids |
| LDL: | Low-Density Lipoprotein |

| | |
|---|---|
| MI: | Media Index |
| ML: | Maximum Likelihood |
| MUFAs: | Monounsaturated Fatty Acids |
| NLEA: | the Nutrition Labeling and Education Act of 1990 |
| NPR: | National Public Radio |
| omega-3: | Omega-3 ($\omega$-3) Fatty Acids |
| PUFAs: | Polyunsaturated Fatty Acids |
| RUM(s): | Random Utility Models |
| S.D.: | Standard Deviation |
| S.E.: | Standard Error |
| SFAs: | Saturated Fatty Acids |
| SUR: | Seemingly Unrelated Regression |
| TFIC: | The Food Industry Center |
| UMN: | University of Minnesota |
| UPCs: | Universal Product Codes |
| USDA: | United States Department of Agriculture |
| vCJD: | variant Creutzfeldt-Jakob Disease |
| VOI: | Value of Information |

# 1. Introduction

## 1.1 Motivation

Consumers in the United States have become increasingly concerned with chronic and preventable health problems. Diet and nutrition have been identified as two of the biggest factors that directly affect their health. Whitney et al. (2010) state that four of the top six leading causes of death in the U.S. have a link with diet.[1] Thus, credible nutritional information has become more valuable to individuals.

While much nutritional information has been available for several decades, new information is constantly appearing as a result of ongoing research. New nutritional information, and its connection with food, is expected to affect consumers' food choices by reducing uncertainty about the health attributes of those foods. Understanding the impact of nutritional and health information on consumers' food choices will contribute to the development of economic models of consumer demand and to the development and implementation of effective communication approaches for changing dietary behaviors. This will not only help policy makers design regulatory and legal polices that

[1] The six causes are: 1) heart disease, 2) cancers, 3) strokes, 4) chronic lung diseases, 5) accidents, and 6) diabetes mellitus. Heart disease, cancers, strokes, and diabetes mellitus have a link with diet.

promote health, but will also help food firms develop products that better match consumers' desire for healthy foods.

The purpose of this study is to estimate the impact of nutrition information provided by popular media on U.S. consumers' purchases. This study also takes into account other factors contributing to their food choices, such as prices, income, household demographics and regional differences. Consumers' knowledge is not observable, so one of the ways to measure the impact of nutrition information is by forming indicators from the content of articles and stories in the media and by looking at the correlation between that content and changes in food purchases.

Consumers' food purchases are assumed to reflect their knowledge of and desire for those products, both of which have been influenced by exposure to public information about those products. It is nearly impossible for researchers to find a comprehensive metric to represent the total flow of information to consumers; hence it is necessary to make several simplifying assumptions when selecting the proxy for nutrition information (Chang and Just, 2007). Even though new information initially becomes available to the public in scientific journals, they are unlikely to be a direct information source for most consumers. Moreover, consumers tend to get the information through public media rather than from doctors or dietitians (Food Marketing Institute, 2008). Therefore, this study makes the assumption that consumers obtain scientific nutritional knowledge through the popular media.

In addition, this study measures the changes in consumer welfare during the period from 1998 to 2007. It is assumed that the accumulated nutritional information has an effect on consumers' welfare as well as their choice behavior.

## 1.2 Contributions

This study makes three major contributions. First, it examines the impact that positive, scientific nutritional information, as it is presented by the mass media, has on consumer demand. Most of the studies of the impact of information on food demand have been done in the context of foodborne illnesses or food safety events, especially on meat (Taylor and Phaneuf, 2009; Piggott and Marsh, 2004; Burton and Young, 1996). In terms of nutritional information, most studies have analyzed the impact of negative nutrition information such as the link between dietary cholesterol and egg consumption (Brown and Schrader, 1990; Chang and Just, 2007). Moreover, while many studies were conducted to analyze the advertising effect (Ippolito and Pappalardo, 2002; Capps and Park, 2002), the impact of scientific nutritional information is rarely analyzed. This study focuses on more objective and reliable information, based on scientific evidence, than the information obtained by an advertisement of a particular product.

Second, this study is a more comprehensive examination of the impact of information sources on food purchases. Specifying a "media index" based on a single information source such as newspapers and simply counted the raw number of articles is a common practice in many previous studies (Piggott and Marsh, 2004; Burton and Young, 1996; Liu et al., 1998; Verbeke and Ward, 2001; Ippolito and Pappalardo, 2002; Chang and Just, 2007). Compared to those studies, studies that utilize multiple media types of information sources are relatively rare (Feick et al., 1986; Kinsey et al. 2009). This study utilizes multiple media types and employs computer-coded content analysis to identify the types of messages and their connection to health. Computer-coded content analysis produces a more detailed indicator of the content and is also good at handling huge amounts of text data, but it remains underused for demand analysis.

Third, this is a unique study which conducts the welfare analysis for the cumulative value of diet and health information using a discrete choice model. Up until now, the welfare analysis in discrete choice models has been conducted mostly to estimate the user benefits in the context of transportation studies (Castiglione et al., 2003; Odeck et al., 2003; Gupta et al., 2004; Chorus and Timmermans, 2009). The welfare analysis regarding food consumption usually involves the retrieval of a cost function rather than formulating a discrete choice model (Foster and Just, 1989; Teisl et al., 2001; Mazzocchi et al., 2004). This study calculates both the value of information and changes in consumer surplus from a discrete choice model specification as consumer welfare measures.

### 1.3 Methodologies

Two datasets are combined in this study. Consumption data are from ACNielsen Homescan® consumer panel study.[2] These data are scanned purchase records from more than 7,000 households that participated in the collection of purchase data from 1998 to 2007 in the 48 continental states. Media data come from the online database called LexisNexis® Academic. The transcripts and articles from multiple information sources such as newspapers, newswires, TV, radio, and magazines are picked up by keyword searches in LexisNexis® Academic and then put into content analysis software called InfoTrend®[3] to generate scores that represent the intensity of messages about the health benefits and developmental benefits of omega-3 fatty acids.

Since it is impossible to know which particular articles or transcripts consumers respond to, their exposure to the nutritional information is estimated by analyzing the volume and contents of articles and transcripts in the media over time. Consumers' responses to food safety events, often used as an example in the study of information impact on food choices, are typically temporary. Purchases recover from the shock after a short lag. In contrast, consumers' responses to nutritional information could be slow and cumulative. This study incorporates the effect of time by specifying the discounted

---

[2] Data were obtained under a memorandum of understanding between The Food Industry Center (TFIC), the University of Minnesota (UMN) with Principle Investigator Professor Jean Kinsey and the United States Department of Agriculture (USDA) Economic Research Service (ERS) in compliance with requirements of the AC Nielsen Homescan® consumer panel.

[3] InfoTrend® was developed by Professor David Fan, University of Minnesota.

media index, which reflects the presumed delayed impact of messages as information is added to the stock of knowledge or beliefs in consumers' minds (Verbeke and Ward, 2001). Another regression analysis including current and cumulative media index from the first period to the previous period is also conducted to see the time effect.

While the motivation for this study is a general interest in the nutritional content of foods, eggs enhanced with omega-3 fatty acids are its primary focus. Omega-3 fatty acids have received growing attention because of their scientifically proven health benefits. The most famous benefit is their ability to help reduce the risk of cardiovascular disease, which was first noticed in epidemiological studies among Greenland Inuits (Bang et al., 1980). Since then, more than 8,000 research publications support omega-3 fatty acids' health benefits. In September 2004, the Food and Drug Administration (FDA) concluded that there was enough scientific evidence to allow companies to make qualified health claims on food labels about two specific omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Fatty fish, walnuts, flaxseed, and canola oil are rich in omega-3 fatty acids. In addition to these foods, omega-3 fatty acids are also now available as many kinds of omega-3 fortified products and dietary supplements. The development of innovative functional food products is a major trend in today's food industry (Chase et al., 2007). Among a variety of food products fortified with omega-3, omega-3 fortified eggs are one of the most popular products (Mintel, 2008). The omega-3 eggs are rich in omega-3 but taste the same as regular eggs[4] and therefore offer an easy way of increasing omega-3 in the diet, without changing the diet or turning to supplements. Although these eggs usually sell at a premium price compared to the typical eggs, the number of omega-3 eggs purchased has increased as a result of the growing knowledge of the health benefits.

Households' monthly purchase of eggs is categorized into three choices: a) purchase of regular eggs only, b) purchase including omega-3 eggs (either purchase of omega-3 eggs only or purchase of both regular eggs and omega-3 eggs), or c) no purchase of eggs, in the month.[5] The households that never buy eggs throughout the year were excluded from this study. Binary choice models are used to study whether they buy omega-3 eggs in the month, conditional on buying some eggs in a given month. Multiple choice models include the households that did not buy any eggs in the month but purchased them sometime during the study period. The empirical models used for a binary discrete choice are the logistic (logit) and probit regression models. A multinomial logit model is employed for multiple choice models.

Regarding the welfare analysis, the consumer surplus is calculated following the method Train (2003) explained in his book. Also, the value of information is obtained based on the theoretical framework of Foster and Just (1989) and Teisl et al. (2001). As a measure of information change, the first year of the analysis (1998) and the last year of

[4] In this study, non-omega-3 eggs are called "regular eggs."
[5] a) 59.0%, b) 2.9%, and c) 38.1%, respectively.

the analysis (2007) are used as before and after the change, respectively. The analysis is conducted using a subsample of households that participated in the survey both in 1998 and in 2007, and that bought omega-3 eggs in either year. The consumer surplus, which is derived from the logit formulation, is used as an approximation of the compensating variation as Cherchi et al. (2004) did.

# 2. Background

This chapter provides background information on the product of interest in this study; omega-3 fatty acids enhanced eggs.

## 2.1 Omega-3 fatty acids

### 2.1.1 Science and Nutrition of Fatty Acids

Dietary fatty acids are classified into three major categories by their chemical structure: saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs), and polyunsaturated fatty acids (PUFAs).[6] SFAs contain no carbon-carbon double bond and they are solid at room temperature. The examples of the products that contain SFAs are butter, lard, and palm oil. Most plant fats such as nuts, canola, and olive oil are high in MUFAs, which contain one double bond and are liquid at room temperature. PUFAs contain two or more double bonds and are also liquid at room temperature. Some examples of foods containing PUFAs are fish, soy, and sunflower seeds. Omega-3 fatty acids are dietary fats categorized as one type of PUFAs. In addition to these three categories of fatty acids, trans fats (trans fatty acids, or “partially hydrogenated oils”) are

[6] Fatty acids are a component of fat.

created in an industrial process called "hydrogenation" that adds hydrogen to liquid vegetable oils to make them more solid. Trans fats are found in many commercially packaged foods such as French fries, microwaved popcorn, or hard stick margarine. These dietary fatty acids are summarized in Table 1.

**Table 1 Dietary Fatty Acids**

| Fatty Acids | Double Bond | Room Temperature | Examples of Food | CHD Risk* |
|---|---|---|---|---|
| Saturated fatty acids (SFAs) | No | Solid | Mainly from animal sources, meat and dairy (milk fat) such as fatty beef, lamb, pork, poultry with skin, beef fat (tallow), lard and cream, butter, cheese, and other dairy products made from whole or reduced-fat (2%) milk. | Increase |
| Monounsaturated fatty acids (MUFAs) | One | Liquid | Canola oil, olive oil, peanut oil, sunflower oil, avocados, and many nuts and seeds | Decrease |
| Polyunsaturated fatty acids (PUFAs) | Two or more | Liquid | Vegetable oils (soybean oil, corn oil and safflower oil), oily fish (salmon, tuna, mackerel, herring and trout), and most nuts and seeds | Decrease |
| Trans fats | One or more | Solid | Commercial baked goods (pastries, biscuits, muffins, cakes, pie crusts, doughnuts and cookies), fried foods (French fries, fried chicken, breaded chicken nuggets and breaded fish), snack foods (popcorn, crackers), and traditional vegetable shortening or stick margarine | Increase |

*CHD: coronary heart disease

Important examples of omega-3 fatty acids are alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). ALA is the precursor to EPA and DHA. Once eaten, the body converts ALA to EPA and DHA which are more readily used by the body. ALA is classified as essential fatty acids (EFAs) because they are not synthesized in the human body. Hence, they must be supplied through diet or supplementation.

Fatty fish such as salmon, tuna, mackerel, halibut, and herring, and fish oils are rich sources of EPA and DHA. Algae and seaweed also contain abundant quantities of EPA and DHA. On the other hand, rich sources of ALA are vegetable oils (e.g., soybean, hempseed, and canola oil), with flaxseed having the highest concentration. It is also found in green leafy vegetables and walnuts.

.

### 2.1.2 Health Benefits

All fats are not created equal, particularly when it comes to heart health. In fact, fatty acids have extreme variation in how they impact blood lipids associated with coronary heart disease (CHD) (Packaged Facts, 2007). Some fats promote our health positively while others increase our risks of heart disease. Roughly speaking, while SFAs and trans fats are "bad" fats, MUFAs and PUFAs are "good" fats. In particular, the health benefits of omega-3 fatty acids have received a great deal of attention in the media.

The most famous benefit of omega-3 fatty acids is their ability to help reduce the risk of cardiovascular disease. This benefit was first noticed in epidemiological studies among Greenland Inuits (Bang et al., 1980). The researchers suggested that Inuits have a low rate of cardiovascular diseases despite a diet rich in fat because the marine animals (e.g., fish, seal, and whale) they consume contain high levels of omega-3 fatty acids. Since then, cardiovascular benefits of omega-3 fatty acids have been documented in many studies. For example, the studies by von Schacky et al. (1999) and Friedberg et al. (1998) found that patients who were given fish oils had lower triglyceride levels. These results imply the heart-healthy benefits of omega-3 fatty acids because high triglyceride concentrations in the blood contribute to high cardiovascular mortality rate. Recently, the Omega-3 Index, which measures omega-3 fatty acids in red blood cells, was proposed by Harris and von Schacky (2004) to evaluate a new risk factor for death from coronary heart diseases (CHD) based on the fact that the fatty acid composition of red blood cells reflects long-term intake of EPA and DHA.

More than 8,000 research publications support the health claims of EPA and DHA. Only calcium has as much scientific evidence for importance in human health. (Packaged Facts, 2007). In addition to the cardiovascular benefits, intake of omega-3 fatty acids may also protect against health conditions including rheumatoid arthritis (Horrobin, 1987), asthma (Broughton et al., 1997), age-related macular degeneration (Seddon et al., 2001), premature birth (Allen and Harris, 2001), epileptic seizure

(Schlanger et al., 2002), prostate cancer (Terry et al., 2001), endometrial cancer (Terry et al., 2002), and so on.

It is noteworthy that DHA plays a prominent role in promoting cognitive function and eye health and also assists in nervous system development of infants (Nettleton, 1993). Hence, the demand for DHA is highest during the latter part of pregnancy and infancy (Ghebremeskel et al., 2000). Since the major benefits of omega-3 fatty acids relate to heart conditions and cognitive development, omega-3 fatty acids have been shown to have the greatest impact on health at the beginning of the lifecycle and at older ages. Hence, marketers of omega-3 enhanced foods are targeting two very different consumer groups: very young children and aging adults (Packaged Facts, 2007).

### 2.1.3 Regulatory Framework and Consumption Guidelines

In September 2004, the Food and Drug Administration (FDA) concluded that there was enough scientific evidence to allow companies to make qualified health claims on food labels about two specific omega-3 fatty acids, EPA and DHA.[7] The FDA allows the use of the following language on packages, *"supportive but not conclusive research shows that consumption of EPA and DHA omega-3 fatty acids may reduce the risk of coronary heart disease. One serving of [name of food] provides [x] grams of EPA and*

[7] In 2000, the FDA announced a similar qualified health claim for dietary supplements.

*DHA omega-3 fatty acids. [See nutrition information for total fat, saturated fat and cholesterol content.]"*

As described previously, ALA is synthesized by the body and converted into DHA and EPA. This is a process that has been found to be inefficient as only a small portion of the ALA gets converted into EPA and DHA. For this reason, ALA can be identified only as a good source of omega-3 fatty acids in health claims. Besides, omega-3 health claims were not allowed if the foods exceed 13 grams of total fat or 60 mg of cholesterol per serving.

The ideal amount of omega-3 intake is not clearly defined. In 2000, the FDA recommended that consumers not exceed more than a total of 3 grams per day of EPA and DHA omega-3 fatty acids, with no more than 2 grams per day from a dietary supplement because some scientific studies show that consumption levels well over 3 grams per day may lead to excessive bleeding. Kris-Etherton et al. (2002) concluded that taking 0.5 to 1.8 grams of EPA+DHA per day significantly reduces deaths from heart disease. The 2005 Dietary Guidelines Advisory Committee recommended the consumption of two, 4-ounce servings of fish high in EPA and DHA per week to reduce the risk of CHD. The current average intake of omega-3 fatty acids in the US is about 1.6 grams per day, with only 0.1-0.2 grams being EPA and DHA (Kris-Etherton et al., 2002).

The other consideration is the balance between omega-3 fatty acids and omega-6 fatty acids. Omega-6 fatty acids are also a family of PUFAs and found in grains, meats, and the seeds of most plants (Table 2). Like ALA - converts into EPA or DHA - in case of omega-3 fatty acids, linoleic fatty acids (LA), found in omega-6 fatty acids, converts into arachidonic acids (AA). Since AA competes with ALA to some extent, excessive consumption of foods rich in omega-6 may compromise the conversion of ALA to EPA or DHA, which in turn adversely affects health. Although some experts believe the evidence indicates a 4:1 ratio would be optimal, the current ratio of LA to ALA consumption in the US ranges from 15:1 to 20:1 due to the increased consumption of LA-rich vegetable oils and meats and declining fish consumption (IFIC, 2005). This imbalance, along with an omega-3 fatty acids deficiency, is associated with increased risk of serious health diseases.

**Table 2 Omega-3 and Omega-6 Fatty Acids**

| | Name | Structure* | Food Source |
|---|---|---|---|
| Omega-3 | alpha-linolenic acid (ALA) | 18:3n-3 | Walnuts, flaxseed oil, and canola oil |
| | eicosapentaenoic acid (EPA) | 20:5n-3 | Fatty fish and fish oils |
| | docosahexaenoic acid (DHA) | 22:6n-3 | Fatty fish and fish oils |
| Omega-6 | linoleic acid (LA) | 18:2n-6 | Corn, safflower, soybean, cottonseed, and sunflower oils |
| | gamma-linolenic acid (GLA) | 18:3n-6 | Evening primrose oil, borage oil, and black current seed oil |
| | arachidonic acid (AA) | 20:4n-6 | Meat, poultry, and eggs |

*18:3n-3 means 18 carbon atoms with 3 double bonds of the omega-3 configuration, and so on.

### 2.1.4 Omega-3 Product Market

Marketers started advertising the omega-3 content of enhanced foods after the FDA allowed omega-3 health claims in 2004. It was first around early 2006 that such products entered mainstream U.S. supermarkets because many of the first entries into this category came from very small marketers and were limited in distribution, primarily to health/natural foods stores and specialty stores (Packaged Facts, 2007).

The omega-3 market has been growing rapidly. By the estimation of Packaged Facts (2007), the retail market for omega-3 enhanced foods and beverages in the U.S. is $100 million in 2002, $2 billion in 2006, and will reach $7 billion by 2011. The compound annual growth rate for the period from 2002 to 2011 is estimated to be 60.3%. Mintel (2008) estimated in a different way and reported that the U.S. market for food products fortified with omega-3 has grown from very small in the 1990s to $600-$800 million per year in 2007. While only 76 new food and beverage product labels made a reference to their omega-3 content in 2002, 409 new foods and beverages made reference to omega-3 content in 2006 (Packaged Facts, 2007). Omega-3 dietary supplements sales also grew by 30-40% annually from 2002 to 2006, and they have been the fastest-growing dietary supplement products since 2000 (Mintel, 2008).

Many efforts are underway to introduce new products which contain omega-3 fatty acids. For example, omega-3 fatty acids are being artificially added to many types of food products. New generation of plants such as flaxseeds which have increased level of omega-3 fatty acids has been developed by genetic modification and animal feed is enhanced with omega-3 fatty acids. Nowadays, omega-3 fatty acids can be found not only in the foods which naturally contain omega-3 fatty acids such as fatty fish but also in a variety of product categories such as milk, yogurt, eggs, margarine, bread, pasta, and even pork and chicken. Since the suppliers have diminished the discoloration, staling, and fishy smell that used to accompany the product, omega-3 is now even more appealing to consumers (Packaged Facts, 2007).

### 2.1.5 Consumer Awareness

Seaton (2006) stated that factors that have led to the expanded use and development of products containing omega-3 fatty acids include an increased understanding of the benefits of omega-3 fatty acids, growth in consumer awareness of their own health deficiencies, developments in formulation technologies, and a positive regulatory environment.

The International Food Information Council Foundation (IFIC, 2005) surveyed consumer attitudes toward functional foods. Of 519 consumers who responded to a question regarding the relationship between omega-3 fatty acids and reduced risk of heart disease, 78% were aware of the relationship. Of that figure, 43% were already consuming omega-3 fatty acids and 39% were likely or somewhat likely to consume them. Regarding the relationship between omega-3 fatty acids and cognitive development especially in children, 55% of the 493 respondents who answered the question said they were aware of the relationship. Of that figure, 45% were already consuming omega-3 fatty acids and 34% were likely or somewhat likely to consume them.

According to Mintel's consumer survey (2008), 30% of the respondents said that they had purchased omega-3 fatty acids products; however, nearly as many (26%) said they were not sure whether they did or not. The survey by the Packaged Facts (2007) found that only 41% of mothers and expectant mothers knew they should be consuming omega-3 fatty acids during pregnancy (in addition to the more well-known calcium and folic acid), underscoring a need for more education. Consumer awareness of omega-3 fatty acids has grown tremendously in recent years, but there is still a substantial percentage of U.S. consumers have not been reached by the omega-3 health trend.

## 2.2 Functional Foods

As consumers have become increasingly health conscious, food producers have developed new and innovative products to meet these new demands. One of the results has been the development and marketing of a growing spectrum of products called functional foods. A wide range of functional food products are now available, such as probiotic yogurts, omega-3 milk and eggs, vitamin E and C enhanced soft drinks, and breakfast cereals with various health claims.

Conceptually, functional foods fall in the area between foods and medicine because they are foods with specific health-promoting properties (Kotilainen et al. 2006). The FDA has no formal definition for functional foods, but cites the definition by the Institute of Food Technologists (IFT); *"foods and food components that provide a health benefit beyond basic nutrition (for the intended population). Examples may include: conventional foods; fortified, enriched, or enhanced foods; and dietary supplements."*

New product development has increased at a rapid rate and the sales of functional foods have risen worldwide. However, it is difficult to estimate the exact size of the market due to the lack of a formal definition for functional foods. The estimated size of the global functional food market was $85 billion in 2006, which accounted for 37.6% of the global nutrition industry (Nutrition Business Journal, 2007).

## 2.3 Case of Omega-3 Fortified Eggs

Omega-3 fortified eggs are one of these innovative functional foods. Though eggs inherently contain omega-3 fatty acids to some extent, egg producers are aggressively incorporating hen feeding initiatives to boost the omega-3 content of eggs.

The development of omega eggs began at the University of Nebraska. Researchers found that adding a percentage of flax, canola oil, or other omega-3 rich products to chicken feed would produce eggs that have an increased level of Omega-3. The most common addition, flaxseed, must be added at a level of 10% to have optimal results (Rich and Dahlhoff, 2003). The University of Nebraska holds the trademark for Omega Eggs and the patent for the feeding system, and the name Omega Eggs is licensed to regional poultry farms.

Omega Eggs are high in omega-3 and contain less saturated fat than conventional eggs. The typical egg has about 60mg of omega-3 fatty acids but the omega-3 enhanced egg can have levels as high as 350mg (Rich and Dahlhoff, 2003). The number of calories, the amount of protein, and the total fat remain almost the same to that of regular eggs, while cholesterol is slightly less in some omega-3 enriched eggs than regular eggs. (Paravolidaki, 2008). The omega eggs taste the same as regular eggs and therefore offer an easy way of increasing omega-3 in the diet, without changing the diet or turning to supplements. Although these eggs usually sell at a premium price compared to the typical eggs, the number of omega-3 eggs purchased has increased as a result of the growing knowledge of the benefits of omega-3 fatty acids.

According to Mintel’s consumer survey (2008), omega-3 eggs are the most popular products among the omega-3 fortified foods. About 47% of respondents who have bought omega-3 products said that they regularly buy omega-3 supplements. Similarly, about 46% of these respondents said they regularly buy omega-3-enriched eggs. Other regularly purchased foods include cereal (40%), milk (39%), yogurt (38%), and oily fish (37%). Female respondents were more likely to buy omega-3 fortified foods, while men were more likely to buy supplements.

Consumers may have the perception that increasing egg consumption results in high blood cholesterol levels, which leads to cardiovascular disease. The American Heart Association (AHA) recommends limiting cholesterol consumption to less than 300 mg per day for most people, mentioning that a medium egg has about 185 mg and a large egg has about 215 mg of cholesterol, all in the yolk. However, as Lewis et al. (2000) suggested, most consumers can eat twelve omega-3 enriched eggs per week without an increase in total or Low-density lipoprotein (LDL) cholesterol level.[8] In addition, van Elswyk et al. (1998) stated that eating four omega-3 enriched eggs per week resulted in a significant decrease in blood platelet aggregation, which is a risk factor for coronary heart disease. Thus, omega-3 eggs appear to be healthier for most people compared to regular eggs and an easy way to introduce omega-3 benefits into their diet.

[8] Not all cholesterol is bad, but LDL is "bad" cholesterol. Higher LDL levels leads to a greater risk for a heart attack.

# 3. Part I Media Effect on Egg Purchase Probability

In Part I, U.S. household’s probability of purchasing omega-3 eggs between 1998 and 2007 is estimated.

## 3.1 Literature Review

Previous studies of structural changes in food demand have included the impact of new information as possible determinants or explanatory variables. The assumption is that the information allows consumers to make better decisions about consumption, and therefore information is valuable to, and used by, consumers. In this respect, the inclusion of information variables in a demand equation reflects the hypothesis that information will alter consumers' attitudes and affect their consumption patterns.

Several types of information variables have previously been introduced for use in demand analysis. They vary in terms of the information sources, aggregation method, and the assumption that the information effect takes place over time. In addition, there are several methods for demand modeling. These issues are discussed in this section, along with the results at the end.

### 3.1.1 Information Variables

Consumers use a variety of sources for nutrition information. Depending on the source, consumers may acquire varying amounts of information due to the differences in the type, quality, and perceived credibility of the information (Nayga et al. 1998). Information sources involve nutrition labels on food products, experts such as health professionals or nutritionists, broadcast media such as radio or television, print media such as newspapers or magazines, and the Internet. It is nearly impossible for researchers to find a comprehensive metric to represent the total flow of information to consumers; hence it is necessary for researchers to make several simplifying assumptions when selecting the proxy for nutrition information (Chang and Just, 2007).

U.S. Grocery Shopper Trends by the Food Marketing Institute (FMI, 2008) published survey data on consumers' nutrition information sources and levels of trust in the data source in 2005 (Figure 1). A sample of 1,017 U.S. shoppers who were (very or somewhat) concerned about the nutritional content of the food they ate were asked if different nutrition information sources were "used as a source" and/or "trusted as a source" on a regular basis. The Internet and magazines are the most frequently used sources for finding nutrition information on a regular basis (46%). Doctors are the fourth choice, following TV. In what FMI calls the "Dr. Me" trend, people are increasingly researching their own health issues.[9] The media play a great role in finding nutritional

[9] In 2008, doctors fell to the fifth choice. The most frequently used source in 2008 is the Internet (49%).

information, but still shoppers seems to have more confidence in doctors. Another consumer survey of 200 samples at four supermarkets in New Jersey by Nayga et al. (1998) found that the majority (56%) indicated that some form of media source was the primary source of nutrition information.[10]

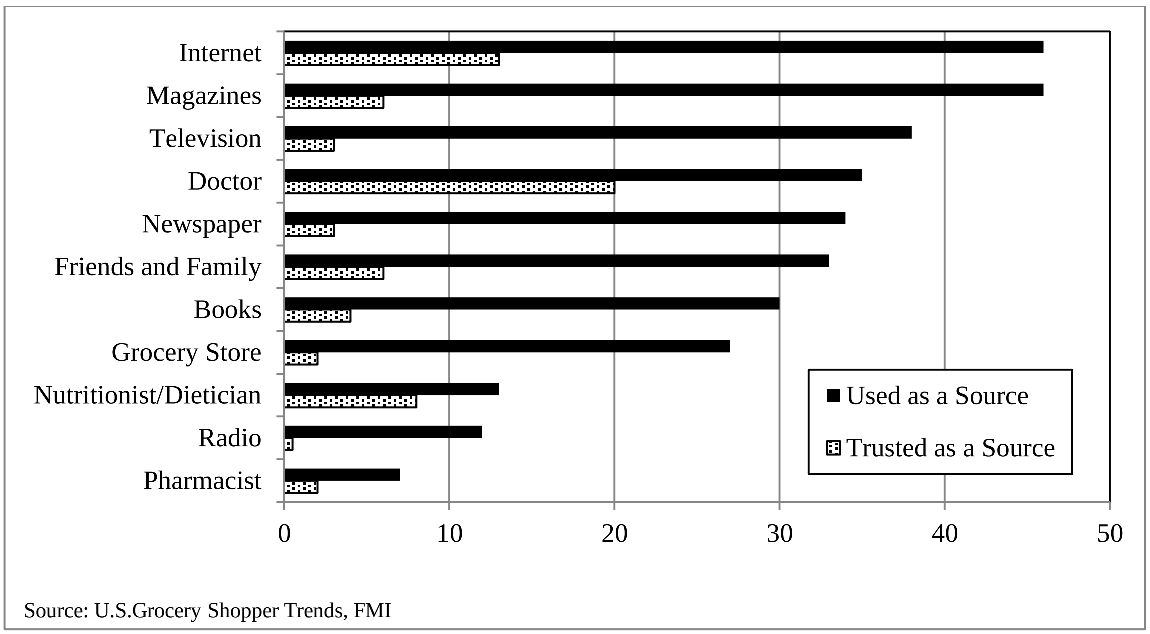



**Figure 1 Sources of Nutrition Information and Levels of Trust in 2005**

Some previous research on the impact of information is based on scientific journal databases. For example, Brown and Schrader (1990) searched articles in the Medline database. The underlying assumption is that someone reads those scientific medical journals and clearly transfers the information to consumers. This assumption of

[10] The breakdown is: 10% of the sample indicated health organization publications or food company publications, 33% indicated books, magazines or newspapers, and 13% indicated radio or television.

full information flows from science to consumers is recognized as a major drawback of this approach (Verbeke and Ward, 2001).

This study focuses on more direct information flows to the consumer: the impact of popular media. For searching articles or transcripts in the media, the LexisNexis® search engine has been used in many studies including Taylor and Phaneuf (2009), Piggott and Marsh (2004), and Burton and Young (1996); all studied the impact of food safety information on meat demand.

One shortcoming of past studies is that they have often relied on only one media type as the information source. The studies by Piggott and Marsh (2004), Burton and Young (1996) and Mazzocchi (2006) took food safety information from the top fifty English language newspapers in the United States. Liu et al. (1998) analyzed the articles of two major newspapers in Honolulu. Verbeke and Ward (2001) used TV news reports to examine the effect of advertising and food safety on meat. Ippolito and Pappalardo (2002) searched advertising content from magazines: five leading women's magazines and three of the most popular general readership magazines.

Compared to those studies, studies that utilized multiple media types are relatively rare. Feick et al. (1986) analyzed consumers' information search using six information sources (packaging labels, magazines and newspapers, books, family and friends, doctors, and TV) and emphasized the importance of examining consumers' use of a variety of information sources. Kinsey et al. (2009) searched in national and local newspapers, network and cable TV, radio, news magazines, and the internet.

Emphasizing the importance of a variety of information sources, this study examines multiple media types.

In the studies analyzing information effect on consumer demand, the articles obtained from databases such as LexisNexis® are converted into information variables. There are several issues in these conversions. First, the articles picked up by keyword search do not always convey the message one expects. For example, the fact that the word of “omega” exists in an article does not necessarily indicate the omega-3 fatty acids’ health benefit. It could simply be a name of the company, or sales figure of a product named “omega”. Instead of counting the raw number of the articles or transcripts as a measure of media exposure as the studies discussed thus far have done, computer-coded content analysis produces a more detailed indicator of the content and is also good at handling huge amounts of text data. There are only a few studies which have made use of content analysis for demand analysis. One example is the study by Fan and Holway (1994), which used computer content analysis for analyzing the factors of use of cocaine by high school seniors.

Second, when searching multiple media types, there is an issue of the “reach” of media intensity since some media types reach a larger audience than other sources. Additionally, the amount of media exposure attributed to each media type varies by media type. Kinsey et al. (2009) addressed these issues and dealt with the former by weighing the media types[11] and with the latter by normalization.[12] Following their method, this study weights the media types based on the FMI survey mentioned earlier on consumers' source of nutrition information and normalizes article/transcript counts across media types.

Since the articles retrieved from this database are classified by their exact date of dissemination, the time unit of the analysis is flexible. Clarke (1976) concluded that annual intervals are too long and that weekly results probably are biased downward because the purchase cycle is probably longer than a one week data interval. The majority of the studies have chosen monthly periodicity, Taylor and Phaneuf (2009) and Chang and Just (2007) for example. Some studies chose quarterly periods, such as Piggott and Marsh (2004) and Burton and Young (1996). Some chose weekly (Kinsey et al. 2009) in order to capture the short-term effect. Following the majority of the studies, monthly periodicity is chosen for this empirical analysis.

### 3.1.2 Effect over Time

The effect of mass media coverage is expected to be cumulative, extending back several months (Verbeke and Ward, 2001). One needs to make an assumption on the number of lags and the depreciation rate of accumulated information to incorporate the

[11] The weights for each media source were based on their survey. Each subject was asked to indicate which of the selected media outlets they considered as their primary source of news.
[12] See subsection 3.3.4 for details.

effect over time. The lagged index reflects the presumed delayed impact of messages as information is added to the stock of knowledge or beliefs in consumers' minds. The depreciation of the information effect is also important, not only because of memory discounting effects, but also due to the time-varying marginal effect of additional information (Mazzocchi, 2006).

These time effects of information variables have been handled in various ways. Smith et al. (1988) included three-period lags of the media coverage variable, mentioning that higher-order polynomials as well as additional lagged terms for media were added to the regression but the estimated coefficients for them were statistically insignificant. Burton and Young (1996) put a media index into the demand equations in two ways: the number of articles per quarter to capture the short-run effects, and the cumulative number of articles to capture the long-run effects. Verbeke and Ward (2001) did not use lagged values but expressed the variable as a function of current value and past values going five periods back, thus extending the total response interval to a period of 6 months. Taylor and Phaneuf (2009) created indices that are 30-day rolling averages of the number of newspapers articles published during the previous two weeks.

Research has suggested that information effects decline over time, as the time lag between consumers' exposure to the information and their consumption widens. Thompson and Eiler (1975) estimated advertising lags for the impact of milk advertising on sales. In New York city, the effect of advertising lasted for six months, with the greatest impact occurring at two months after the initial advertising. In Albany and

Syracuse, however, the effect dissipated more rapidly, and the greatest impact occurred in the month of the initial advertising. In the case of milk contamination in Hawaii, Smith et al. (1988) stated that the estimated lagged effect of negative media exhibits a geometrically declining shape with the greatest impact occurring in the month of information release. Liu et al. (1998) also examined a case of milk contamination, and found that the best models are the one included current month of and one month lags of negative media coverage variables, and the one with four and five month lags of positive media coverage.

In relation to the nutrition information, Kim and Chern (1999) compared three cholesterol information indices in explaining Japanese consumption of fats and oils: the Brown and Schrader (1990) index, which is the cumulative number of published medical journal articles; a cubic weighting function; and a geometrical declining lag index. Their results showed that the latter two which assume diminishing effect provided a better measure than the cumulative index, with a geometrically declining lag having the greatest explanatory power. Chang and Just (2007) used a generalized Bayesian updating model to see the health information impact on U.S. egg consumption. They found that health information will decay to a point of unimportance in a matter of a few weeks without a constant and consistent stream of confirming information.

### 3.1.3 Demand Modeling Methods

Most studies on consumer demand have used an approach based on the estimation of a demand function, which permits a retrieval of a cost function. Examples include an almost ideal demand system (AIDS) model with a media index (Burton and Young, 1996; Verbeke and Ward, 2001), a generalized AIDS model which incorporates pre-committed quantities into the AIDS model (Piggott and Marsh, 2004), and a dynamic AIDS model which incorporates the price change and the budget share of the previous period (Mazzocchi et al., 2004). Since the AIDS model estimates the share of the goods of interest, there should be several food categories. Many previous studies used beef as the product of interest to analyze the shock of Bovine Spongiform Encephalopathy (BSE).

In this study, the percentage of the households that have purchased omega-3 enhanced eggs is small.[13] With a large number of households indicating no purchase of these particular products, it is not possible to apply standard demand analysis using flexible functional forms, such as the AIDS model (Fuller et al., 2004). In particular, zero consumption observations could reflect a corner solution in the utility maximization process.

To handle censored or truncated data, the Tobit model (Tobin, 1958) has been widely used for demand estimation using survey data with zero consumption

[13] See subsection 3.2.2.

observations. This model assumes that the two decisions, on whether to buy and how much to buy, are affected by the same set of factors. Parsons et al. (2006) employed a random-effects Tobit model to estimate the effects of pfiesteria-related fish kills on the demand for seafood.[14] Taylor and Phaneuf (2009) estimated the impact of food safety information on the demand for meat and poultry using a seemingly unrelated regression (SUR) Tobit model.

The double-hurdle model (sometimes called a generalized Tobit model) proposed by Cragg (1971) has also been used in several studies. This model assumes that the two decisions, on whether to buy and how much to buy, are affected by different sets of factors. It is useful when there is a reason to believe that some factors affecting market participation do not impact consumption levels directly, or some explanatory variables may have opposite impacts on the participation and consumption decisions (Fuller et al., 2004). Fuller et al. (2004) used a double-hurdle model to analyze demographics, cultural factors, and purchasing behaviors that influence dairy consumption in China.

Discrete choice analysis is a useful method that can be used to empirically test theoretical hypotheses about choice behavior, such as those affected by some product attributes (Zou and Hobbs, 2006). Discrete choice models include logit and probit models, which estimate the probability of choosing a given alternative. These two models are similar, with a difference of the assumption of the error term distribution; normal distribution for a probit model and logistic distribution for a logit model.

---

[14] Pfiesteria is an organism that could possibly pose threats to healthy water conditions during an outbreak. It has been known to kill fish, and could have adverse effects on human life (Phiesteria and the Environment, 2011).

Discrete choice models have been commonly used for demand analysis of functional foods including special eggs. Goddard et al. (2007) used several models including a logit model and a multinomial conditional logit model to analyze Canadian consumers' preferences for egg purchases. Their multinomial conditional logit model examined five types of eggs: normal eggs, omega-3 eggs, free run/range eggs, organic eggs, and vitamin enhanced eggs. Chase et al. (2007) used the ordered probit model for Canadian consumers' purchasing behavior of omega-3 products (eggs, milk, yogurt and milk). They assumed that a household faces a choice between never purchasing, purchasing once, purchasing occasionally and purchasing frequently.[15] The findings of these studies are in the results section in this chapter.[16]

A more generalized version of the logit model - Berry, Levinsohn and Pakes (BLP, 1995) model - considers unobserved product characteristics and consumer heterogeneity in tastes for product characteristics. This model allows for two types of interactions between consumer characteristics and product characteristics: interactions between observed consumer characteristics and product characteristics, and interactions between unobserved consumer characteristics and product characteristics. Lopez and Matschke (2007) applied the BLP market equilibrium model to estimate consumers' tastes for beer characteristics as well as for the cultural region of origin. Chidmi and

[15] They labeled a household that buys omega-3 eggs five or more times a year a "frequent" purchaser of omega-3 eggs.
[16] See subsection 3.1.4.

Lopez (2007) extended the BLP model to ready-to-eat cereals in Boston by including consumer taste for supermarket retail services.

### 3.1.4 Results

Research on the impact of information on food consumption has often taken the form of measuring the impact of the foodborne illness (food safety) events on meat demand. The results are not consistent. According to Piggott and Marsh (2004), the impact of meat safety information on meat consumption in the U.S. is small. A similar result was found by Taylor and Phaneuf (2009), which showed that the food safety information does not have a statistically significant effect on the households' consumption except for the households in urban areas. In contrast, Verbeke and Ward (2001) showed that fresh meat demand is more sensitive to the potential health risks associated with meat consumption than to the price changes. Similarly, Burton and Young (1996), who examined the demand for meat in the UK after the BSE crisis, found that the impact of media information on beef consumption over this period was significant both in terms of short-run impact and long-run impact.

Turning to the impacts of positive information on food demand, many previous studies focused on advertising. Their results suggested advertising significantly affect consumers' purchases. Capps and Park (2002) showed that both branded and generic advertisements played an important role in pork consumption decisions. Jensen et al.

(1992) examined the impact of a national advertising campaign of calcium and showed a positive effect on both the probability of purchasing dairy products and on the quantity of dairy products purchased. Chang and Kinnucan (1991) examined the roles of cholesterol information and advertising in explaining consumption trends of butter in Canada. Their results suggested that increased consumer awareness of cholesterol contributed to lower butter consumption. However, despite the growing presence of unfavorable information, the industry advertising campaign had a positive effect on butter demand.

Regarding the impact of nutrition information in the media on food demand, the impact of cholesterol information on demand has been studied commonly. Brown and Schrader (1990) showed that information on the links between cholesterol and heart disease decreased U.S. per capita egg consumption by 16% to 25% by the first quarter of 1987. Chang and Just (2007) estimated the same impact but used the popular media (magazines) and also found a significant negative impact on U.S. egg consumption. Kim and Chern (1999) found that increasing consumer health information on cholesterol appears to have reduced the consumption of hog grease, tallow, and palm oil, and increased the use of fish oil, but had no major impact on the demand for other vegetable oils in Japan.

The study by Goddard et al. (2007) used revealed preference analysis to see the value-added egg product purchase behavior. The results differed by the provinces (Alberta and Ontario) and modeling (frequency model and choice model); however, organic eggs were the ones all households were willing to pay the most for in general. Free run eggs are also popular in Ontario, but less so than organic. One of the findings of their study is that there may be some misunderstanding of the relative nutritional benefits of the different types of eggs or other human health aspects of agricultural production.

Several studies have found demographic differences in the demand for omega-3 products. Chase et al. (2007) developed profiles of Canadian omega-3 consumers and found that an aging (baby boomer) population is the most frequent purchaser of omega-3 products, and the presence of children increases the purchasing frequency of omega-3 yogurt and omega-3 margarine. The Mintel report (2008) showed that 30% of respondents in their consumer survey purchased omega-3 products. Household income is the strongest factor affecting omega-3 purchase, and product awareness tends to decline sharply with decreasing household income. Age is also an important factor; individuals over age 45 are more likely to buy omega-3 products. In light of these results, one of the purposes of this study is to explore the impact of demographic differences and regional differences on consumers' purchases of omega-3 eggs in the U. S. between 1998 and 2007.

## 3.2 Consumption Data

This study uses AC Nielsen Homescan® consumer panel data from 1998 to 2007 in the U.S. in order to analyze consumers' purchase behavior.[17]

### 3.2.1 AC Nielsen Homescan® Consumer Panel

AC Nielsen Homescan® Consumer Panel data consist of daily retail food purchases for in-home use as well as the household demographics. Each household is provided a handheld scanner and asked to scan universal product codes (UPCs) of all purchased products after each shopping trip. After the scanning, all household upload the purchase records to ACNielsen through a landline phone or through the Internet. [18]

One advantage of working with daily purchase data is the flexibility to choose the frequency of observation. Verbeke and Ward (2001) stated that econometric literature indicates that the impact of communication on demand is generally a matter of months rather than of quarters or years. A monthly periodicity is chosen for this empirical analysis, which is consistent with many previous papers such as Taylor et al. (2009) or Clarke (1976). Hence, this daily purchase record is aggregated to the monthly level data.

---

[17] Data are obtained under a contract. See section 1.3.
[18] Einav et al (2008) concluded about the credibility of Homescan® data as "the overall accuracy of self-reported data by Homescan panelists seems to be in line with other commonly used (government-collected) economic data sets."

Since AC Nielsen has started collecting new and additional information over time, some variables in these purchase records are not available for entire period. For example, organic claims are not available before 2004. Table 3 shows the variables available for entire period, from 1998 to 2007, in purchase record.

**Table 3 Variables Available in Purchase Record**

| | |
|---|---|
| - Household ID | - Form |
| - Purchase date [YYMMDD] | - Formula |
| - Product module | - Container type |
| - Brand | - Salt content |
| - Size | - Style |
| - Multipack indicator [yes/no] | - Type |
| - UPC | - Product |
| - UPC description | - Variety |
| - Quantity | - Store name identifier |
| - Price paid – deal | - Channel type identifier |
| - Price paid – nondeal | - Product group identifier |
| - Coupon value | - Department identifier |
| - Flavor | |

To recruit the panelists, ACNielsen uses both direct mail and the Internet. The direct mail method is used to ensure the recruitment of low-income or ethnic groups who may not have access to the Internet. About 30% of the recruitment is conducted using direct mail, and the other 70% is through the Internet. The offered incentives are the same for all households to avoid potential distortions in purchasing behavior. [19] Only

[19] The offered incentives are not associated with industry firms or products in order to prevent potential bias. Therefore there are no coupons, discounts, and other incentives provided by manufacturers, specific retailers, restaurants, etc.

households who report data for at least ten out of 12 months during the year are included. They are from fifty two major cities and 9 remaining areas in the 48 continental states.

In addition to the purchase record, demographic information about the household is available. Households are required to update their demographic information annually. As with purchase records, some variables in these records are missing depending on the year because of the addition of the questions about the demographics. The variables available for entire period in demographics record are shown in Table 4. Variables used in the analysis are selected from these purchase data (Table 3) and demographics data (Table 4).

**Table 4 Variables Available in Demographics Record**

| | |
|---|---|
| - Household ID | - Marital status |
| - Household size | - Male head occupation |
| - Household income | - Female head occupation |
| - Age of female head | - Household composition |
| - Age of male head | - Race |
| - Age and presence of children | - Hispanic origin |
| - Male head employment | - Region |
| - Female head employment | - Market ID |
| - Male head education | - Projection factor |
| - Female head education | |

### 3.2.2 Egg Purchase

The number of households that bought eggs in the year is summarized by the types of eggs in Table 5. Here the eggs mean fresh shelled eggs.[20] Omega-3 eggs are distinguished by the UPC code description. Gradually the number of households that bought omega-3 eggs increased during this period.

**Table 5 Number of Households That Bought Eggs in the Year by Egg Types**

| | Any eggs | Regular eggs only | (%) | Omega-3 eggs only | (%) | Both kind of eggs | (%) |
|---|---|---|---|---|---|---|---|
| 1998 | 7304 | 6819 | (93.4) | 20 | (0.3) | 465 | (6.4) |
| 1999 | 6826 | 6347 | (93.0) | 23 | (0.3) | 456 | (6.7) |
| 2000 | 7182 | 6700 | (93.3) | 27 | (0.4) | 455 | (6.3) |
| 2001 | 7769 | 7254 | (93.4) | 37 | (0.5) | 478 | (6.2) |
| 2002 | 8197 | 7608 | (92.8) | 51 | (0.6) | 538 | (6.6) |
| 2003 | 8337 | 7587 | (91.0) | 53 | (0.6) | 697 | (8.4) |
| 2004 | 37592 | 33310 | (88.6) | 291 | (0.8) | 3991 | (10.6) |
| 2005 | 36839 | 32712 | (88.8) | 331 | (0.9) | 3796 | (10.3) |
| 2006 | 35600 | 31206 | (87.7) | 357 | (1.0) | 4037 | (11.3) |
| 2007 | 59384 | 50460 | (85.0) | 715 | (1.2) | 8209 | (13.8) |

The households did not purchase any egg products in a given year are removed from the panel data for the purposes of this study. On average, 5.4% of the sample is excluded (Table 6).

[20] Egg consumption has two components: shell eggs and egg products. Shell eggs are those eggs purchased in cartons in the grocery store. Egg products are eggs that have been processed and sold in liquid or dried form. In this study, shell eggs indicated by the product module code "4100" in the data are used.

**Table 6 Households That Bought Eggs in Any Month in the Year**

| | Number of HHs that bought eggs in any month in the year | Number of HHs in Homescan® | % of the HHs that bought eggs |
|---|---|---|---|
| 1998 | 7304 | 7624 | 95.8 |
| 1999 | 6826 | 7124 | 95.8 |
| 2000 | 7182 | 7523 | 95.5 |
| 2001 | 7769 | 8216 | 94.6 |
| 2002 | 8197 | 8685 | 94.4 |
| 2003 | 8337 | 8833 | 94.4 |
| 2004 | 37592 | 39577 | 95.0 |
| 2005 | 36839 | 38863 | 94.8 |
| 2006 | 35600 | 37786 | 94.2 |
| 2007 | 59384 | 63156 | 94.0 |
| Total | 215030 | 227387 | 94.6 |

Table 7 shows the price of eggs. Prices per unit (dozen) of product (eggs) are subsequently calculated by dividing total expenditure by total quantity for each

**Table 7 Annual Average Price and Consumer Price Index for Eggs**

| | Regular Eggs (dozen) | Omega-3 Eggs (dozen) | CPI for Eggs (1982-84=100) |
|---|---|---|---|
| 1998 | 1.06 | 1.82 | 135.48 |
| 1999 | 0.97 | 1.85 | 128.22 |
| 2000 | 1.00 | 1.96 | 131.93 |
| 2001 | 1.04 | 2.05 | 136.48 |
| 2002 | 1.03 | 2.12 | 138.28 |
| 2003 | 1.22 | 2.21 | 157.36 |
| 2004 | 1.25 | 2.30 | 166.88 |
| 2005 | 1.02 | 2.33 | 144.21 |
| 2006 | 1.09 | 2.36 | 151.16 |
| 2007 | 1.51 | 2.41 | 195.47 |

Souces: BLS (for CPI)

individual (dozen) eggs purchase.[21] Interestingly, while regular egg prices fluctuated over the period, the omega-3 eggs price increased steadily. The mean of the regular eggs price is $1.21 (standard deviation: 0.55) and the mean of the omega-3 eggs price is $2.28 (standard deviation: 0.22) for the whole period.

Figure 2 illustrates the monthly average price of eggs (dozen) by type (primary axis) and the percentage of omega-3 egg purchase in total egg purchase (secondary axis) in this study. There are a variety of factors determine the eggs price such as the balance of demand and supply or the price of feed.

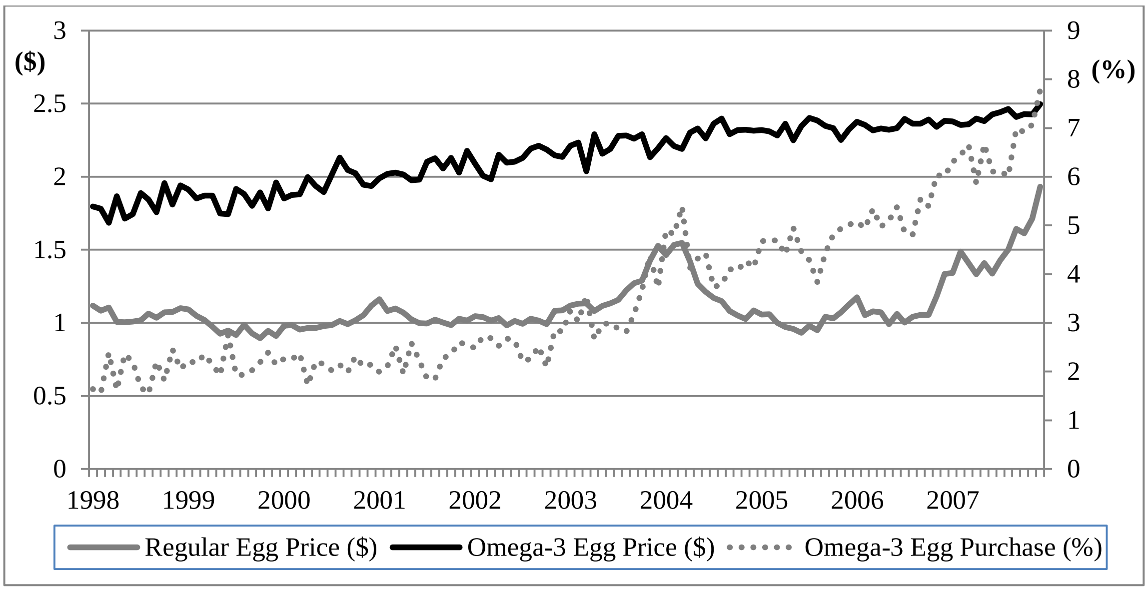



**Figure 2 Monthly Egg Prices (dozen) and the Share of Omega-3 Eggs Purchase**

To see the seasonal change, Table 8 shows the seasonal average price of eggs by type and the percentage of omega-3 egg purchase in total egg purchase in this study for

[21] Prices in this study are nominal values.

the whole period.[22] While regular egg price is higher in winter, omega-3 egg price is relatively constant across the seasons.[23] The share of omega-3 egg purchase in total egg purchase is relatively smaller in the summer.

**Table 8 Seasonal Egg Prices and the Share of Omega-3 Eggs Purchase**

| | Winter | Spring | Summer | Fall |
|---|---|---|---|---|
| Omega-3 Egg Purchase (%) | 4.91 | 4.71 | 4.38 | 4.92 |
| Regular Egg Price ($, dozen) | 1.29 | 1.19 | 1.15 | 1.22 |
| Omega-3 Egg Price ($, dozen) | 2.28 | 2.25 | 2.31 | 2.29 |

### 3.2.3 Demographics

The Nielsen Homescan® panel is a stratified random sample that is selected based on both geographic and demographic targets. The dataset used in this study is an unbalanced panel in the sense that not all households participated for all sample years. Starting 2004, the number of households suddenly increased due to different purchasing criteria used by the USDA, ERS (Table 6).[24] However, the distributions of the demographic and geographic characteristics of the households within a sample year do not vary noticeably from year to year. Detailed statistics of the household demographic variables for each year are listed in Appendix A.

[22] Winter: December-February, Spring: March-May, Summer: June-August, and Fall: September-November.
[23] Egg production increases naturally during the spring and early summer. In contrast, egg demand is highest prior to holiday periods, particularly Thanksgiving, Christmas and Easter. The balance yields the seasonal price change.
[24] USDA, ERS purchase the data from ACNielsen. Although the number of households has increased, the format of purchase data for the product of interest in this study (eggs) has not changed.

**Table 9 Household Panel Demographic Variables (Average of 1998-2007)**

| Demographic Variable | Frequency | % | Demographic Variable | Frequency | % |
|---|---|---|---|---|---|
| Number of Households | 21503 | | **Age of Head** | | |
| **Household Size** | | | Under 25 Years | 94 | 0.4 |
| Single Member | 5171 | 24.0 | 25-29 Years | 542 | 2.5 |
| Two Members | 8648 | 40.2 | 30-34 Years | 1223 | 5.7 |
| Three Members | 3222 | 15.0 | 35-39 Years | 1819 | 8.5 |
| Four Members | 2753 | 12.8 | 40-44 Years | 2479 | 11.5 |
| Five Members | 1126 | 5.2 | 45-49 Years | 2925 | 13.6 |
| Six Members | 384 | 1.8 | 50-54 Years | 2969 | 13.8 |
| Seven Members | 125 | 0.6 | 55-64 Years | 4953 | 23.0 |
| Eight Members | 46 | 0.2 | 65+ Years | 4500 | 20.9 |
| Nine+ Members | 28 | 0.1 | **Education of Head** | | |
| **Household Income** | | | Grade School | 111 | 0.5 |
| Under $5000 | 156 | 0.7 | Some High School | 629 | 2.9 |
| $5000-$7999 | 234 | 1.1 | Graduated High School | 5628 | 26.2 |
| $8000-$9999 | 215 | 1.0 | Some College | 6962 | 32.4 |
| $10,000-$11,999 | 325 | 1.5 | Graduated College | 5868 | 27.3 |
| $12,000-$14,999 | 590 | 2.7 | Post College Grad | 2305 | 10.7 |
| $15,000-$19,999 | 1062 | 4.9 | **Race** | | |
| $20,000-$24,999 | 1518 | 7.1 | White | 17816 | 82.9 |
| $25,000-$29,999 | 1429 | 6.6 | Black | 2132 | 9.9 |
| $30,000-$34,999 | 1625 | 7.6 | Oriental | 474 | 2.2 |
| $35,000-$39,999 | 1449 | 6.7 | Other | 1081 | 5.0 |
| $40,000-$44,999 | 1488 | 6.9 | **Hispanic** | | |
| $45,000-$49,999 | 1400 | 6.5 | Yes | 1349 | 6.3 |
| $50,000-$59,999 | 2359 | 11.0 | No | 20154 | 93.7 |
| $60,000-$69,999 | 1967 | 9.1 | **Region** | | |
| $70,000-$99,999 | 3467 | 16.1 | East | 3701 | 17.2 |
| $100,000 & Over | 2218 | 10.3 | Central | 5218 | 24.3 |
| **Presence of Children** | | | South | 8097 | 37.7 |
| Yes | 5633 | 26.2 | West | 4487 | 20.9 |
| No Children Under 18 | 15870 | 73.8 | **Major Market** | | |
| | | | Yes | 8703 | 40.5 |
| | | | No | 12800 | 59.5 |

Table 9 shows the statistics of demographics calculated as averages across the ten sample years. The average household size is 2.45. The average annual household income calculated by taking the middle value of the range (e.g., take $6,500 as a value of $5,000-$7,999) is $55,150. [25]

The data have information on both male and female head of the household but do not indicate which one is the main decision maker. Assuming that the female head is a main decision maker for grocery purchases, female head is taken as a head in this study. If there is no female head in the household, the male head is considered as a head. The average age of head calculated by taking the middle value of the range (e.g., use 27 years old for 25-29 years old) [26] is slightly over 52. The education of the head is used as a dummy variable for whether she/he has a college degree or not.

Major markets are specified in the Homescan® data as presented in Table 10 on the next page. While there are nine major markets from 1998 to 2003, there are 23 major markets from 2004 to 2007. The number of the cities indicated as a major market increased in 2004 in accordance with the additional data collection so that the ratio between major markets and non-major markets are consistent.

[25] $150,000 is used as a value for $100,000 & over.
[26] 22 years old is used as an age for under 25 years and 70 years old is used as an age for 65+ years.

**Table 10 Major Markets**

| Scantrack Market | 1998-2003 | 2004-2007 |
|---|---|---|
| Boston | | Major Markets |
| Chicago | Major Markets | Major Markets |
| Houston | | Major Markets |
| Los Angeles | Major Markets | Major Markets |
| New York | Major Markets | Major Markets |
| San Francisco | Major Markets | Major Markets |
| Seattle | | Major Markets |
| Atlanta | Major Markets | Major Markets |
| Dallas | | Major Markets |
| Denver | | Major Markets |
| Detroit | | Major Markets |
| Miami | | Major Markets |
| Minneapolis | | Major Markets |
| Philadelphia | Major Markets | Major Markets |
| St. Louis | | Major Markets |
| Tampa | | Major Markets |
| Baltimore | Major Markets | Major Markets |
| Phoenix | | Major Markets |
| Columbus | | Major Markets |
| Washington, DC | Major Markets | Major Markets |
| Charlotte | | Major Markets |
| Sacramento | | Major Markets |
| San Antonio | Major Markets | Major Markets |

## 3.3 Media Index

Media index, which implies consumers' exposure to the information, is constructed from information data via content analysis. In this study, the LexisNexis® Academic search engine is used as the information data source. After the articles are obtained from LexisNexis®, content analysis software called InfoTrend® is used. The scores produced by InfoTrend® are transformed into the media index.

### 3.3.1 LexisNexis® Academic

Since it is not possible to figure out from the Homescan® data which media the sample households actually see (or hear), a different dataset which suggests how much media access consumers have to the nutrition information is necessary. In this study, LexisNexis® Academic search engine is used to determine the quantity of information available to consumers via popular media sources. LexisNexis® is an online source for researching news, business, and legal topics.[27] Previous study often used LexisNexis® for obtaining media information (Taylor and Phaneuf, 2009; Piggott and Marsh, 2004; Burton and Young, 1996: all studied the impact of food safety information on meat). In addition, the InfoTrend®, content analysis software used in this study, was originally developed to utilize the output from the LexisNexis® so there is no need for further customization.

[27] LexisNexis® provides customers with access to billions of searchable documents and records from more than 45,000 legal, news and business sources (LexisNexis® website)

### 3.3.2 Information Data Collection

The media stories containing the words about omega-3 fatty acids are sampled from January 1, 1998, through December 31, 2007. Only the information sources which are included in the LexisNexis® database for entire period are selected so as not to be affected by the number of information sources the LexisNexis® carries. That is, an increase in the number of articles should be associated with the increase in media attention, not with the increase in the number of information sources LexisNexis® contains.[28]

The sample of media stories mentioning omega-3 fatty acids is obtained from 76 information sources including newspapers (40), newswires (6), TV (6), radio (1), and magazines (23) archived in the LexisNexis® Academic electronic database. The selected information sources are shown in Table 11. The retrieved stories show some overlap due to the use of the same news sources.[29] They are left as they are without making any further efforts on eliminating duplicates because multiple appearances are assumed to imply more media attention and that they reach a broader audience or the same audiences more often.

---

[28] For example, when we select "magazines" as a source type, articles from various magazines can be obtained. However, the magazines included in the LexisNexis® database changes over time. The number of the articles retrieved from "magazines" could increase with the increase in the number of magazines included.

[29] Newswires intend to supply news reports to news organizations such as newspapers.

**Table 11 Selected Information Sources**

| Newspapers | |
|---|---|
| Arkansas Democrat-Gazette (Little Rock, AR) | The Daily News of Los Angeles (Los Angeles, CA) |
| Chicago Daily Herald (Chicago, IL) | The Dallas Morning News (Dallas, TX) |
| Chicago Sun-Times (Chicago, IL) | The Denver Post (Denver, CO) |
| Contra Costa Times (Walnut Creek, CA) | The Houston Chronicle (Houston, TX) |
| Daily News (New York, NY) | The Kansas City Star (Cansas City, MO) |
| Detroit Free Press (Detroit, MI) | The Miami Herald (Miami, FL) |
| Fort Worth Star-Telegram (Fort Worth, TX) | The Milwaukee Journal Sentinel (Milwaukee, WI) |
| Las Vegas Review-Journal (Las Vegas, NV) | The New York Post (New York, NY) |
| Pittsburgh Post-Gazette (Pittsburgh, PA) | The New York Times (New York, NY) |
| San Antonio Express-News (San Antonio, TX) | The Orange County Register (Orange County, CA) |
| San Jose Mercury News (San Jose, CA) | The Oregonian (Portland, OR) |
| Seattle Post-Intelligencer (Seattle, WA) | The Philadelphia Inquirer (Philadelphia, PA) |
| St. Louis Post-Dispatch (St.Louis, MO) | The Post-Standard (Syracuse, NY) |
| St. Paul Pioneer Press (St.Paul, MN) | The San Francisco Chronicle (San Francisco, CA) |
| St. Petersburg Times (St.Petersburg, FL) | The Star-Ledger (Newark, NJ) |
| Star Tribune (Minneapolis, MN) | The Times Union (Albany, NY) |
| The Atlanta Journal and Constitution (Atlanta, GA) | The Virginian-Pilot (Norfolk, VA) |
| The Boston Globe (Boston, MA) | The Washington Post (Washington, DC) |
| The Buffalo News (Buffalo, NY) | USA Today (Washington, DC) |
| The Columbus Dispatch (Columbus, OH) | Wall Street Journal (New York, NY)[a] |

| Newswires | |
|---|---|
| Business Wire | The Associated Press[b] |
| PR Newswire | University Wire |
| Reuters Health Medical News | UPI (United Press International) |

| TV | |
|---|---|
| ABC News Transcripts | CNN Transcripts[c] |
| CBS News Transcripts | NBC News |
| CNBC/Dow Jones Business Video | PBS[d] |

| Radio |
| --- |
| National Public Radio (NPR) |

| Magazines | |
| --- | --- |
| Advertising Age | Maclean's |
| agricultural research | mmr |
| Brandweek | Mothering |
| business week | New Scientist |
| chain drug review | Newsweek |
| chemistry and industry | The Economist |
| Consumer Reports | The Lancet |
| Current Health 2 | The Progressive Grocer |
| Drug Store News | U.S. News & World Report |
| Environmental Nutrition | Vegetarian Times |
| Essence | Vibrant life |
| Jet | |

[a] Only abstracts are available.

[b] Includes Associated Press Online, The Associated Press, and The Associated Press State & Local Wire. Associated Press Financial Wire is excluded because it is not available for the entire period.

[c] Includs CNN Transcripts and CNN Financial Network Transcripts.

[d] The NewsHour with Jim Lehrer and The Nightly Business Report only.

This selection of the sources is based on the popularity and availability during the period. Popular newspapers and magazines are defined in terms of their circulation. The circulation data of newspapers and consumer magazines taken from Audit Bureau of Circulations are provided in Appendix B and Appendix C, respectively. Assuming that popular media get more people to access the information, each information source from the top of the circulation ranking is checked for the availability over the period. Newswires, TV, and radio are selected mostly based on the availability.[30]

[30] The availability is limited for these information sources so there is not that flexibility on the selection.

The availability is a critical part of the selection. Some information sources are not available in the LexisNexis®.[31] Besides, sometimes the information source restricts the use of the database.[32] Moreover, not all sources are available for the period from 1998 to 2007. Though all media types are affected by this problem to some extent, this coverage period problem is more apparent in magazines than other media types.[33] Furthermore, even though the sources are included for the whole period, the search may not pick up any articles. It is no wonder that some information sources do not contain the keywords specified due to the media's contents and the target audience.

Before selecting the stories by information sources, the source names are checked. The name could differ record by record even though they are the same information source.[34] In addition, the names sometimes change over time.[35] All of these are integrated manually to be identified as one information source.

The search extracts filtered stories that focus on the specific topics of interest. After several tries, "(omega 3 or DHA or fish oil or flaxseed oil or flax seed oil or linseed oil) and health!" is chosen as keywords to pick up the articles on omega-3 fatty acids. DHA is one of the most famous omega-3 fatty acids families. Fish oil, flaxseed oil, flax seed oil or linseed oil contains high amounts of omega-3 fatty acids.

[31] For example, TIME magazine is not available at all.
[32] For example, Los Angeles Times allows academic users to access only the latest 6 months of data.
[33] "Good Housekeeping" or 'O, the Oprah Magazine' (magazines, both are available only from January 2005) are those examples.
[34] For instance, "Seattle Post-Intelligencer" and "The Seattle Post-Intelligencer" (with or without "the"), "St. Paul Pioneer Press" and "Saint Paul Pioneer Press" ("St. " or "Saint"), "The Star – Ledger" and " "The Star Ledger" (with or without hyphen), "National Public Radio" and "NPR" (full name or abbreviation), or "The Dallas Morning News" and "The Dallas Morning News ( Texas )" (with or without state).
[35] For example, MSNBC Business Video changed the name to CNBC/Dow Jones Business Video in 1998.

An exclamation mark (!) is used to truncate a word to find all the words made by adding letters to the end of it. “health!” would find variations on the term acquire such as health, healthy, and healthful. Hence this keyword is meant to focus on the articles on omega-3’s health attributes. The procedure of obtaining articles from LexisNexis® in detail is described in Appendix D.

Note that the keyword search in LexisNexis® yields different results at different times for some reasons. LexisNexis® has the right to add new information sources any time, and it could remove articles previously available all of a sudden.[36] Hence, the search results may not be consistent according to the date the search is conducted. The sample for this study is collected in June 2009.

Once retrieved, the downloaded texts are uploaded to the server and put into the database. They are analyzed by InfoTrend® software for content analysis to score each story referring to omega-3 fatty acids.

### 3.3.3 Content Analysis

As mentioned earlier, since it is hard to track down which particular media consumers exactly respond to, their exposure to the information on omega-3 fatty acids is estimated by analyzing the volume and the contents of articles. Based on the media articles obtained from LexisNexis® academic for the period from 1998 to 2007, a media

[36] The decisions whether to put the articles on the database or not are driven by the publisher rather than the database.

index which is assumed to indicate the impact on the interest and acceptance of its consumption is constructed.

Several previous studies used the article count as a media index (Verbeke and Ward, 2001; Chang and Just, 2007). Although counting is a simple and straightforward method, not all articles convey the message we would like to know. Preliminary investigation has shown that considerable number of stories mention omega-3 fatty acids only in passing. A computer-coded content analysis plays an important role in identifying the type of message and its connection to health.

InfoTrend® is computer software specializing in content analysis, developed by Professor David Fan.[37] This software and method has been used successfully to predict public opinion by analyzing news media accounts on a wide range of topics such as the economy (Fan and Cook, 2003) or the value of forests (Webb et al., 2008).

The coding scheme is the foundation of any content analysis. In the InfoTrend® method, the coding scheme is developed through the creation of customized "lexicons" made up of words and phrases related to particular concepts of interest. Then the development of computer instructions called ''idea transition rules'' specify how various concepts represented by the lexicons are combined to generate new, more complex concepts. For example, a lexicon of terms representing the concept ''healthy'' (e.g., lowers cholesterol, decreases risk of heart attack, develops brain function) could be

[37] Department of Genetics and Cell Biology, University of Minnesota.

combined with a lexicon of terms representing ‘‘omega-3 fatty acids’’ (e.g., omega 3, fish oil, DHA) to code for the concept ‘‘omega-3 fatty acids are good for your health.’’

This step of developing the lexicons and idea transition rules to code the text takes place after downloading filtered textual data from LexisNexis®. This is an iterative process. Refining the customized dictionary by applying it to a sample of text, assessing the accuracy of coding in context, and revising the dictionary and rules as needed is repeated until a satisfactory level of validity is achieved. The computer instructions are developed for several random samples of news text and are then applied without further modification to score stories. The concepts and the lexicons which represent the concepts used in this study are summarized in Table 12 on the next page.

Words in brackets are chosen as lexicons. If there is no space between the bracket and a word inside, it acts as a wild card operator. For example, { benefi} picks up words “benefit”, “benefits”, “beneficial”, and so on. These words are case-insensitive and the order in this table (alphabetical) does not matter. The “irrelevant” concept was created so as not for “DHA” to stand for “dental health alliance”, which is often the case.[38]

[38] Omitting “dha” is not a good option because DHA is commonly used term for omega-3 fatty acids.

**Table 12 Dictionary of Concepts and Lexicons**

| Concept | Lexicon |
|---|---|
| Omega3 | { dha } { d . h . a } { fish oil} { flax} { hemp } { omega } { polyunsaturated } |
| Health | { asthma } { attack} { burst} { cancer } { cardi} { cholesterol } { clot} { dangerous } { death } { disease} { disorder } { health} { heart} { inflammat} { pain } { painful} { risk} |
| Develop | { baby } { babies } { child} { develop} { formula } { growth } { infant} { young} { youth} |
| Good | { benefi} { better } { desirable } { essential } { good } { help} { importan} { improv} { in favor } { maintain} { maintenance } { promising } { recommend} { save} { saving } |
| Bad | { bad } { fishy } { foul} { odor } { smell} |
| Negation | { anti} { never } { no } {not } {n ' t } { other than } { without } |
| Irrelevant | { dental health alliance } |

Three ideas are scored; a) omega-3 is good for any reasons, b) omega-3 is good for human development, and c) omega-3 is good for your health. The interaction term of a) and b) is used for constructing the index for “development.” The idea c) is used for constructing the index for “health.” These ideas are not exclusive and in fact many paragraphs are scored for multiple ideas. Each article is analyzed to check if it conveys any of these ideas.

a) Omega-3 is good for any reasons (*“Omega3Good”*)

This idea aims to capture if the story tells good things of omega-3 in general. Four rules are applied in this order from i) to iv) as follows.

i) If *"Irrelevant"* and *"Omega3"* are within the same paragraph, ignore them.
ii) If *"Negation"* is within 20 words ahead of *"Bad,"* consider them as being *"Good."*
iii) If *"Omega3"* and *"Health"* are within the same paragraph, score them for *"Omega3Good."*
iv) If *"Omega3"* and *"Good"* are within the same paragraph, score them for *"Omega3Good."*

Having analyzed several random samples, almost all of the stories speak well of health attributes of omega-3 fatty acids. Hence, *"Health"* is positioned as a positive *"healthy"* term. Negation term is assumed to give the following term an opposite meaning if they are close enough. It looks that 20 words are reasonable distance based on several trials.[39]

b) Omega-3 is good for the development (*"Omega3Dev"*)

[39] InfoTrend® has an ability to specify the direction (ahead / behind / either) and the number of words apart.

This idea intends to see the impact of household demographics. It is assumed that this idea may attract more attention if they have children or expect to have children. The following two rules are applied.

i) If *"Irrelevant"* and *"Omega3"* are within the same paragraph, ignore them.

ii) If *"Omega3"* and *"Develop"* are within the same paragraph, score them for *"Omega3Dev."*

c) Omega-3 is good for your health (*"Omega3Health"*)

While the idea a) covers "good" in general, the idea c) focuses on health benefits of omega-3 fatty acids. The scores for this idea c) is equal or less than those for idea a). Two rules are applied.

i) If *"Irrelevant"* and *"Omega3"* are within the same paragraph, ignore them.

ii) If *"Omega3"* and *"Health"* are within the same paragraph, score them for *"Omega3Health."*

These scores are added up every time the scoring occurs. However, the final score is based on the number of the paragraphs scored. The paragraph below is extracted from Newsweek on 9/17/2007 for example.

*Studies suggest that women could benefit from taking omega-3 fatty-acid supplements, particularly those containing docosahexaenoic acid (DHA, for short), a type of fat that has been shown to help prevent prematurity and contribute to healthy brain development. A recent study found that women with more vitamin D in their bodies have children with stronger bones; adequate vitamin D is also needed for organ development.*

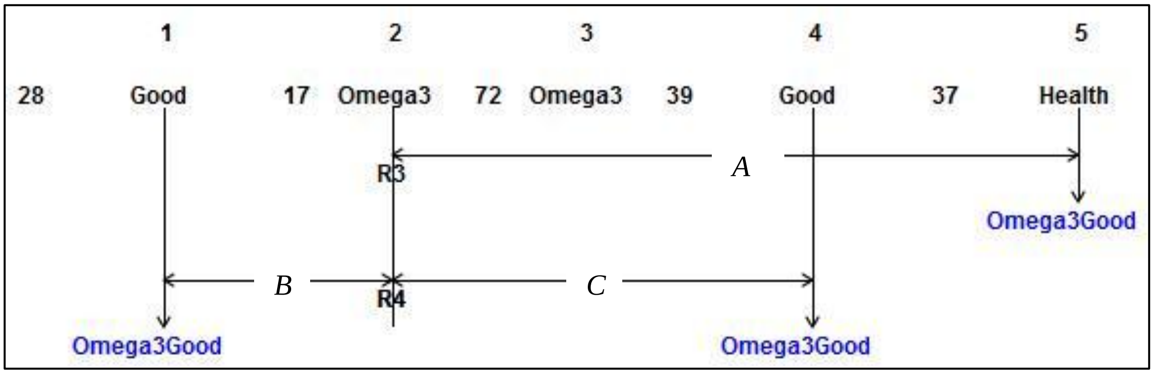
After the coding the above paragraph for the first idea (a), the software analyzes the paragraph according to the rules and yields the following output:

*studies suggest that women could**[1] benefi]**t from taking**[2] omega ]** - 3 fatty - acid supplements , particularly those containing docosahexaenoic acid (**[3] dha ]** , for short ) , a type of fat that has been shown to**[4] help]** prevent prematurity and contribute to**[5] health]**y brain development . a recent study found that women with more vitamin d in their bodies have children with stronger bones ; adequate vitamin d is also needed for organ development. .*

*..........Scores this paragraph (P_ID=2629709, P_NUM=21): Omega3Good=3*

All characters are converted into lower cases. The lexicons detected are indicated by boldface with numbering **[1]-[5]**. InfoTrend® map, produced by InfoTrend® technologies, illustrates the scoring graphically at the same time (Figure 3).

**Figure 3 InfoTrend® Map for the Sample Paragraph**




The lexicons [1]-[5] are shown by the concepts which they belong to; e.g., *"benefit"* is shown as one of the *"good"* concept in this diagram. [40] The numbers between these concepts are the number of words between them; e.g., there are 17 words between the concept [1] (*"Good"*) and the concept [2] (*"Omega-3"*). This paragraph is analyzed if it conveys the idea (a) by the designated rules. The rule (iii) in the idea (a) (shown as R3) applies to the concepts [2] and [5] (shown as *A*), and the rule (iv) in the idea (a) (shown as R4) applies to the concepts [1] and [2] (shown as *B*) and also to the concepts [2] and [4] (shown as *C*), hence the total score becomes three for this paragraph (Omega3Good=3). Each paragraph gets scored in the same way for each idea.[41] Then, the number of paragraphs scored is counted as the score of the story for the idea. Hence, despite the fact that this paragraph gets three scores for the idea (a), it is counted as one score for the idea (a) when the scores are aggregated at the story level.

[40] See Table 12 for the dictionary of lexicons and concepts.
[41] This paragraph is scored for other two ideas as well.

### 3.3.4 Conversion from Scores to Media Index

The scores for each story are converted into media indices. The minimum score of (a) and (b) is considered as a score that represents the omega-3's developmental benefit ("development"), and the score of (c) is considered as a score that represents the omega-3's health benefit ("health").

The scores are then categorized by three media types: a) newspapers and newswires, b) TV and radio, and c) magazines. Scores are summed up for each type on monthly basis. Then, following Kinsey et al. (2009), a media index that incorporates three media types is constructed by standardizing and weighting the scores across media types. Scores for each media types are standardized using the following formula

$$Z_{kt} = \frac{x_{kt} - Min(x_k)}{Max(x_k) - Min(x_k)} \times 100$$

where $Z_{kt}$ is the standardized score for media source $k$ during month $t$, $x_{kt}$ is the score for media source $k$ ($k$=1: newspapers and newswires, $k$=2: TV and radio, and $k$=3: magazines) during month $t$, and Min($x_k$) and Max($x_k$) are the minimum and maximum scores for the $k$th media source over the sample period.

After this standardization, the index involves aggregating standardized scores ($Z_{kt}$) using the following formula

$$S_t = \sum_{k=1}^{3} w_k Z_{kt}$$

where $S_t$ is the media index value for month $t$ and $w_k$ is the weight assigned to the $k$th media source where $\sum_{k=1}^{3} w_k = 1$ and $0 \le w_k \le 1$. The weights for each media source aims to capture the difference in "reach" of media; i.e. some media sources reach a larger audience than other sources. The weights are determined by the survey on consumers' nutrition information sources in 2005 conducted by the Food Marketing Institute (2008).[42] According to the survey, 34% of the survey participants say that they use newspapers as a nutritional information source, and 38% use television, 12% use radio, and 46% use magazines. In this study, TV and radio are integrated since national public radio is the only available source for radio. The response for TV is taken as a response for TV and radio. In this way, the weights becomes $w_{1(\text{newspapers})} = \frac{34}{34+38+46} = 0.29$, $w_{2(\text{TV and radio})} = \frac{38}{34+38+46} = 0.32$, and $w_{3(\text{magazines})} = \frac{46}{34+38+46} = 0.39$. This $S_t$ is used as a media index for current month.

In addition, there may also be time lags between publication in the media and consumers' actual purchase change. Verbeke and Ward (2001) stated that the effect of mass media coverage is expected to be cumulative extending back several months. In order to capture the effect of time, a five-period distributed lag is specified to extend the total response interval to a period of six months.[43] Six months lag is consistent with

---

[42] See subsection 3.1.1 for detail.

[43] In fact, sensitivity analysis on the length is conducted from one month to twelve months, in addition to the six months. There are no noteworthy differences among them.

recommendations by Clarke (1976) and with the approaches followed by Brown and Schrader (1990) or Liu et al. (1998). The lagged index reflects the presumed delayed impact of messages as information is added to the stock of knowledge or beliefs in consumers' minds (Verbeke and Ward, 2001).

Kim and Chern (1999) compared several information indices and concluded that the information index which assumed that the impact of a published article will last indefinitely according to distributed lag structure performed best. Following their specification, this study assumes a monthly decay rate of twenty percent in distributed lag scheme.[44] Thus, the discounted media index $T_t$ becomes

$$T_t = S_t + 0.8S_{t-1} + (0.8)^2S_{t-2} + (0.8)^3S_{t-3} + (0.8)^4S_{t-4} + (0.8)^5S_{t-5}.$$

Since this media index needs the scores of the past five months, the first five months of the data are not used.

These scores and calculated media indexes are summarized in Table 13 on the next page. More detailed data are provided in Appendix E ("health") and Appendix F ("development").

[44] They also mentioned that different assumption of ten percent decay rate yielded a very similar trend of the index.

**Table 13 Statistics of the Scores and Media Indexes**

| | Health | | | | Development | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Min | Max | Mean | S.D. | Min | Max |
| Raw Scores ($x_{1t}$, Newspapers & Newswires) | 60.6 | 37.5 | 7 | 189 | 15.9 | 12.2 | 0 | 50 |
| Raw Scores ($x_{2t}$, TV & Radio) | 3.9 | 5.4 | 0 | 37 | 0.6 | 1.2 | 0 | 7 |
| Raw Scores ($x_{3t}$, Magazines) | 7.3 | 5.8 | 0 | 25 | 1.5 | 1.6 | 0 | 7 |
| Standardized Scores ($Z_{1t}$, Newspapers & Newswires) | 29.4 | 20.6 | 0 | 100 | 31.7 | 24.5 | 0 | 100 |
| Standardized Scores ($Z_{2t}$, TV & Radio) | 8.1 | 13.6 | 0 | 100 | 6.8 | 15.2 | 0 | 100 |
| Standardized Scores ($Z_{3t}$, Magazines) | 28.4 | 23.3 | 0 | 100 | 20.6 | 23.2 | 0 | 100 |
| Current Media Index ($S_t$) | 22.2 | 14.7 | 2.4 | 65.3 | 19.4 | 16.1 | 0.0 | 75.4 |
| Discounted Media Index ($T_t$) | 82.7 | 42.4 | 30.2 | 194.4 | 70.6 | 48.3 | 11.5 | 197.1 |

Figure 4 and Figure 5 on the next page illustrate the change in the current media index and the discounted media index graphically. These two indices move similarly (correlation: 0.82 for “health” and 0.87 for “development”), but the discounted index rises and the gap widens in the second half of the period.

In addition to this discounted media index, cumulative media index which is the summation of the current media index from the first period to the previous period ($\sum_{t=1}^{t-1} S_t$) is used together with current media index $S_t$ in another regression in order to capture the time effect.

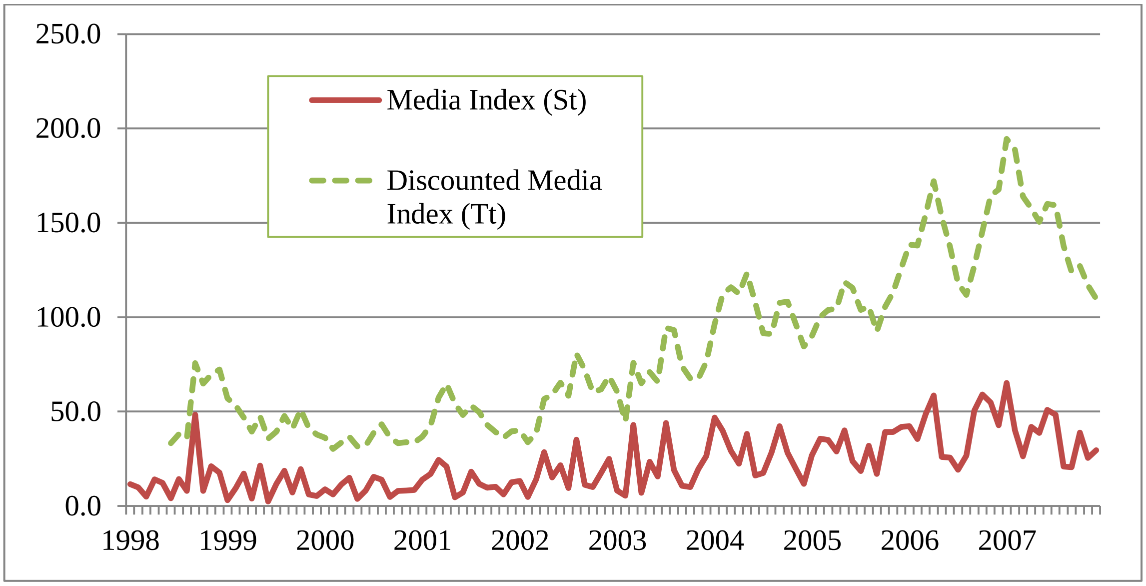



**Figure 4 Media Index ($S_t$) and Discounted Media Index ($T_t$) for the Idea of "Health"**

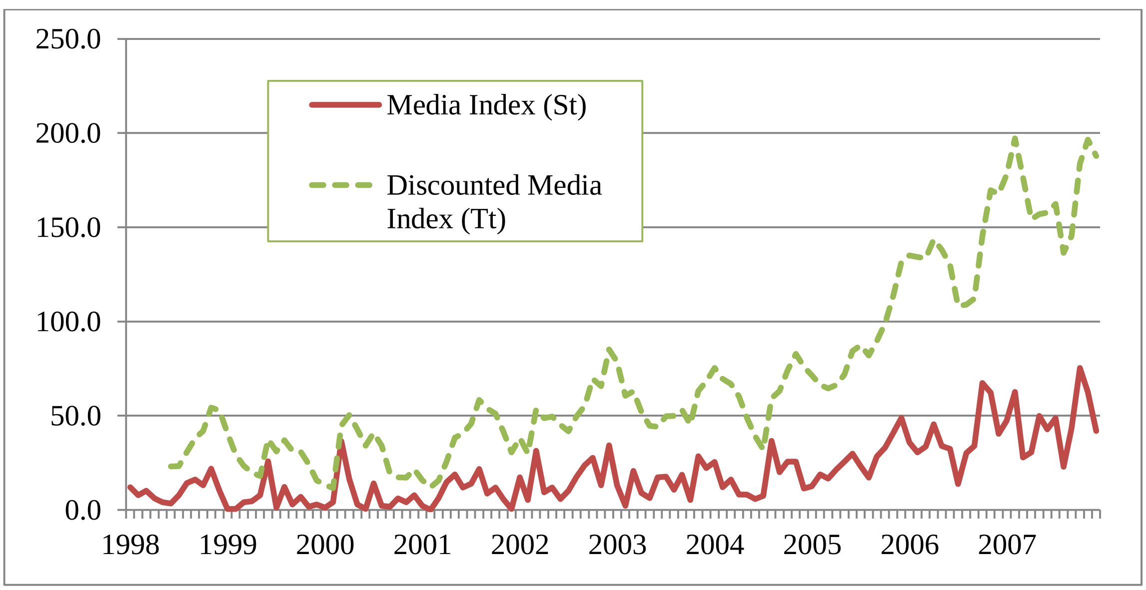



**Figure 5 Media Index ($S_t$) and Discounted Media Index ($T_t$) for the Idea of "Development"**

## 3.4 Theoretical Framework

Traditional theories of the economics of consumer behavior are mainly based on continuous mathematical functions that describe tradeoffs among alternatives in the marketplace. In this study, consumers' (households') monthly purchase of various types of eggs is treated as a discrete variable.[45] Discrete choices generally reveal less information about the choice process than continuous-outcome choices, which makes the econometrics of discrete choice more challenging (Train, 2003).

### 3.4.1 Random Utility Theory

Discrete choice models are often interpreted in terms of underlying structural models of behavior, called random utility models (RUM or RUMs). In this formulation, utilities are treated as random variables not to reflect a lack of rationality in the decision maker but to reflect a lack of information regarding the characteristics of alternatives and/or decision makers on the part of the observer.

Random utility models were first developed by psychologists in the attempt to characterize observed inconsistencies in patterns of individual behavior. Thurstone (1927) originally developed the concepts in terms of psychological stimuli, leading to a binary probit model of whether respondents can differentiate the level of stimulus. Marschak (1960) interpreted the stimuli as utility and provided a derivation from utility

[45] It is also called as a categorical variable.

maximization. Following Marschak, models that can be derived in this way are called random utility models. Later, economists, beginning with McFadden, embraced such models as an econometric representation of maximizing behavior.[46]

A utility level $U_{ij}$ is assigned to each alternative $j = 1, \ldots, J$ for each consumer $i = 1, \ldots, I$. Consumers are assumed to choose the alternative that provides them the highest utility. The utilities are determined by the characteristics of both the individuals making the choice and the alternatives available.

Not all of those determinants are observed, yet one can separate overall utility into a deterministic part, $V_{ij}$, and a stochastic part, $\varepsilon_{ij}$. Then the consumer's utility becomes:

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

The probability $P_{ij}$ that individual $i$ chooses alternative $j$ is equal to the probability that $U_{ij}$ is the largest of the utilities from all J choices: $U_{i1}, \ldots U_{iJ}$ .

Let $Y_i \in \{1 \ldots J\}$ denote the alternative that consumer $i$ chooses. The probability of this choice is:

$$\begin{aligned} P_{ij} &= \text{Prob}(Y_i = j) \\ &= \text{Prob}\left(U_{ij} > U_{ik}\right) \;\; \forall k = 1, \cdots, J: \quad k \neq j \\ &= \text{Prob}\left(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}\right) \;\; \forall k = 1, \cdots, J: \quad k \neq j \\ &= \text{Prob}\left(V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij}\right) \;\; \forall k = 1, \cdots, J: \quad k \neq j \end{aligned}$$

[46] McFadden published many articles on this subject in the 1970s. Among them, his publications in 1978 and in 1981 form his most important contribution to the discrete choice literature and a major component of his Nobel work (de Jong, 2005).

Given the deterministic parts of the utility functions $V_{i1}, \ldots V_{iJ}$ , this probability depends on the assumptions on the distribution of the stochastic error terms $\varepsilon_{i1}, \ldots \varepsilon_{iJ}$. Note that they are based on utility differences only. The addition of a constant to all utilities or multiplying each of the utilities by a constant factor does not change the estimated probabilities.

The deterministic utility components $V_{ij}$ may consist of different types of determinants. Some attributes of the alternatives as faced by the decision maker are labeled $x_{ij}$. and some attributes of the decision maker are labeled $s_i$. Then,

$$V_{ij} = V(x_{ij}, s_i) \quad \forall j$$

The $V_{ij}$ is often called representative utility. It is often reasonable to specify the observed part of utility to be linear in parameters with a constant (Train, 2003).

### 3.4.2 Models for Discrete Choice

When the consumer's choice is between a small numbers of unordered choices, the best way to estimate consumer behavior is to predict the probability of each possible outcome. Factors such as household income, age, and education are gathered in a vector **x** to explain the decision. In the case of a binary choice, the probability is:

$$\text{Prob}(Y = 1|\mathbf{x}) = F(\mathbf{x}, \boldsymbol{\beta})$$

$$\text{Prob}(Y = 0|\mathbf{x}) = 1 - F(\mathbf{x}, \boldsymbol{\beta})$$

The set of parameters $\boldsymbol{\beta}$ determines the impact of changes in $\mathbf{x}$ on the probability. Where $F(.)$ is a cumulative distribution function which suffices the condition below.

$$\lim_{\mathbf{x}'\boldsymbol{\beta}\to+\infty} \text{Prob}(Y = 1|\mathbf{x}) = 1$$

$$\lim_{\mathbf{x}'\boldsymbol{\beta}\to-\infty} \text{Prob}(Y = 1|\mathbf{x}) = 0$$

The probit and logit models are the most common econometric models used in economic studies of discrete choices. The probit model assumes the normal distribution.

$$\text{Prob}(Y = 1|\mathbf{x}) = \int_{-\infty}^{\mathbf{x}'\boldsymbol{\beta}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

$$= \int_{-\infty}^{\mathbf{x}'\boldsymbol{\beta}} \phi(t)\, dt$$

$$= \Phi(\mathbf{x}'\boldsymbol{\beta})$$

where $\phi(.)$ is the probability density function of a standard normal distribution and $\Phi(.)$ is the cumulative density function of a standard normal distribution. On the other hand, the logit model assumes the logistic distribution.

$$\text{Prob}(Y = 1|\mathbf{x}) = \frac{e^{\mathbf{x}'\boldsymbol{\beta}}}{1 + e^{\mathbf{x}'\boldsymbol{\beta}}}$$

$$= \Lambda(\mathbf{x}'\boldsymbol{\beta})$$

where $\Lambda(.)$ indicates the logistic cumulative distribution function.

These models can be extended to multiple choices. McFadden (1973) showed that if (and only if) the $\varepsilon_{ij}$ are independent and identically distributed and follow Type I extreme value (Gumbel) distribution, $\text{F}(\varepsilon_{ij}) = e^{-e^{-\varepsilon_{ij}}}$, then

$$\text{Prob}(Y_i = j) = \frac{e^{V_{ij}}}{\sum_{j=1}^{J} e^{V_{ij}}}$$

Utility is usually specified to be linear in parameters: $V_{ij} = \mathbf{x}_{ij}'\boldsymbol{\beta}$ (Train, 2003). With this specification, the logit probabilities become

$$\text{Prob}(Y_i = j) = \frac{e^{\mathbf{x}_{ij}'\boldsymbol{\beta}}}{\sum_{j=1}^{J} e^{\mathbf{x}_{ij}'\boldsymbol{\beta}}}$$

The probability density function of the normal probability distribution has a higher peak and thinner tails than the logistic probability distribution. These two models tend to give similar probabilities for binary choices, especially for intermediate values. Moreover, it is difficult to justify the choice between the logit and the probit model on theoretical grounds (Greene, 2003). The choice usually relies on mathematical convenience, individual preferences, or familiarity.

## 3.5 Econometric Methods

In this study, households' monthly purchases of eggs, as documented in the ACNielsen Homescan® data across the United States over years from 1998 to 2007, are categorized into three choices in any given month: a) purchase of regular eggs only, b) purchase including omega-3 eggs (either purchase of omega-3 eggs only or purchase of both regular eggs and omega-3 eggs), or c) no purchase of eggs in a particular month.

Households who never buy eggs throughout the year, about 5% of the total households, are excluded from this study.[47] Among the sample that purchases some eggs, the percentages of observations that fall into each category are, a) 59.0%, b) 2.9%, and c) 38.1%, respectively.

The maximum likelihood (ML) estimation method is used in discrete choice method. The dataset for regression analysis is prepared by using SAS.[48] Once the data are cleaned, all regression analyses are conducted using STATA.[49]

### 3.5.1 Binary Choice Models

One way to analyze the consumers' behavior is to see whether they buy omega-3 eggs in the month, conditional on buying some eggs. A binary model can be used if the households that did not buy any eggs during the month are excluded. The probability model is a regression:

$$\begin{aligned} \mathrm{E}[\mathrm{y}|\mathbf{x}] &= 0[1 - F(\mathbf{x}'\boldsymbol{\beta})] + 1[F(\mathbf{x}'\boldsymbol{\beta})] \\ &= F(\mathbf{x}'\boldsymbol{\beta}) \end{aligned}$$

The marginal effects are in general:

[47] See subsection 3.2.2.
[48] SAS version 9.1.
[49] Intercooled STATA version 10.

$$\frac{\partial \mathrm{E}[\mathrm{y}|\mathbf{x}]}{\partial \mathbf{x}} = \left\{\frac{\mathrm{d}F(\mathbf{x}'\boldsymbol{\beta})}{\mathrm{d}(\mathbf{x}'\boldsymbol{\beta})}\right\}\boldsymbol{\beta}$$

$$= f(\mathbf{x}'\boldsymbol{\beta})\boldsymbol{\beta}$$

where *f(.)* is the density function that corresponds to the cumulative distribution, *F(.)*.

For the normal distribution (probit), the marginal effect is:

$$\frac{\partial \mathrm{E}[\mathrm{y}|\mathbf{x}]}{\partial \mathbf{x}} = \left\{\frac{\mathrm{d}\Phi(\mathbf{x}'\boldsymbol{\beta})}{\mathrm{d}(\mathbf{x}'\boldsymbol{\beta})}\right\}\boldsymbol{\beta}$$

$$= \phi(\mathbf{x}'\boldsymbol{\beta})\boldsymbol{\beta}$$

For the logistic distribution (logit),

$$\frac{\partial \mathrm{E}[\mathrm{y}|\mathbf{x}]}{\partial \mathbf{x}} = \left\{\frac{\mathrm{d}\Lambda(\mathbf{x}'\boldsymbol{\beta})}{\mathrm{d}(\mathbf{x}'\boldsymbol{\beta})}\right\}\boldsymbol{\beta}$$

$$= \left\{\frac{e^{\mathbf{x}'\boldsymbol{\beta}} \cdot \left(1 + e^{\mathbf{x}'\boldsymbol{\beta}}\right) - e^{\mathbf{x}'\boldsymbol{\beta}} \cdot e^{\mathbf{x}'\boldsymbol{\beta}}}{\left(1 + e^{\mathbf{x}'\boldsymbol{\beta}}\right)^2}\right\}\boldsymbol{\beta}$$

$$= \left\{\frac{e^{\mathbf{x}'\boldsymbol{\beta}} \cdot \left(1 + e^{\mathbf{x}'\boldsymbol{\beta}} - e^{\mathbf{x}'\boldsymbol{\beta}}\right)}{\left(1 + e^{\mathbf{x}'\boldsymbol{\beta}}\right)^2}\right\}\boldsymbol{\beta}$$

$$= \left\{\frac{e^{\mathbf{x}'\boldsymbol{\beta}}}{\left(1 + e^{\mathbf{x}'\boldsymbol{\beta}}\right)^2}\right\}\boldsymbol{\beta}$$

$$= \Lambda(\mathbf{x}'\boldsymbol{\beta})\left(\frac{1}{1 + e^{\mathbf{x}'\boldsymbol{\beta}}}\right)\boldsymbol{\beta}$$

$$= \Lambda(\mathbf{x}'\boldsymbol{\beta})\left(\frac{1 + e^{\mathbf{x}'\boldsymbol{\beta}} - e^{\mathbf{x}'\boldsymbol{\beta}}}{1 + e^{\mathbf{x}'\boldsymbol{\beta}}}\right)\boldsymbol{\beta}$$

$$= \Lambda(\mathbf{x}'\boldsymbol{\beta})\{1 - \Lambda(\mathbf{x}'\boldsymbol{\beta})\}\boldsymbol{\beta}$$

For computing marginal effects, one can evaluate the expressions at the sample means of the data or evaluate the marginal effects at every observation and use the sample average of the individual marginal effects. In large samples these will give similar results (Greene, 2003). In this study, marginal effects are calculated at the means of the independent variables.[50]

The marginal effects of dummy explanatory variables cannot be obtained by taking the derivatives. Instead, the appropriate marginal effect for a dummy independent variable *d* is expressed as:

$$\text{Marg.Eff.}=\text{Prob}\left[Y=1\middle|\bar{\mathbf{x}}_{(d)},d=1\right]-\text{Prob}\left[Y=1\middle|\bar{\mathbf{x}}_{(d)},d=0\right]$$

where $\bar{\mathbf{x}}_{(d)}$ denotes the means of all the other variables in the model.

Marginal effects and elasticities are similar in that they reflect the rate of change of one variable relative to the rate of change of a second variable. While marginal effects are expressed as unit changes, elasticities are expressed as percentage changes. More specifically, the marginal effect for a choice model is the change in the probability of outcome given a unit change in an explanatory variable, *ceteris paribus* (Hensher et al., 2005).

In this study, there are repeated observations over time on households. Each observation is formed into the group they belong to, which is the household in this case. The observations are independent across groups (clusters) but not necessarily within groups. The standard errors allow for intragroup correlation, relaxing the usual

[50] The data used in this study contain more than one million observations.

requirement that the observations be independent. This clustering affects the standard errors, but not the estimated coefficients.

When there is clustering, individual observations are no longer independent, and the estimated “likelihood” does not reflect it. In these cases, Sribney (2005) suggests that the Wald tests should be used instead of likelihood-ratio tests for testing hypotheses about the coefficients. The null hypothesis is that the coefficients of the variables are jointly equal to zero. If the test fails to reject the null hypothesis, it suggests that removing the variables from the model will not substantially harm the fit of that model, since a predictor with a coefficient that is very small relative to its standard error is generally not doing much to help predict the dependent variable.

### 3.5.2 Multiple Choice Models

Multiple choice models may also be used to analyze egg purchase behavior. In these models, households that decided not to buy any eggs in the month are included, so there are three choices. Again, the choices in this study are: 0=purchase of regular eggs only, 1=purchase including omega-3 eggs (either omega-3 eggs only or mixed), and 2=no purchase of eggs in the month.

In the case of multiple choices, the probit model has rather limited use because of the need to evaluate multiple integrals of the normal distribution. On the contrary, the logit model has been widely used in many fields (Greene, 2003). In this study, only the logistic distribution is assumed for multiple choice models.[51] The choice model specifies possibility as

$$\text{Prob}(Y_i = j) = \frac{e^{\mathbf{x}_i'\boldsymbol{\beta}_j}}{\sum_{k=0}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}} \qquad j = 0, 1, \ldots, J. \tag{1}$$

The form of the logit model results if $J$=1. Because the probabilities sum to one, it can be normalized by setting $\beta_0 = 0$. Hence, (1) becomes:

$$\text{Prob}(Y_i = j|\mathbf{x}_i) = \frac{e^{\mathbf{x}_i'\boldsymbol{\beta}_j}}{1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}} \tag{2}$$

Specifically, $J$=2 in this study, hence,

$$\text{Prob}(Y_i = 0|\mathbf{x}_i) = \frac{1}{1 + e^{\mathbf{x}_i'\boldsymbol{\beta}_1} + e^{\mathbf{x}_i'\boldsymbol{\beta}_2}}$$

$$\text{Prob}(Y_i = 1|\mathbf{x}_i) = \frac{e^{\mathbf{x}_i'\boldsymbol{\beta}_1}}{1 + e^{\mathbf{x}_i'\boldsymbol{\beta}_1} + e^{\mathbf{x}_i'\boldsymbol{\beta}_2}}$$

$$\text{Prob}(Y_i = 2|\mathbf{x}_i) = \frac{e^{\mathbf{x}_i'\boldsymbol{\beta}_2}}{1 + e^{\mathbf{x}_i'\boldsymbol{\beta}_1} + e^{\mathbf{x}_i'\boldsymbol{\beta}_2}}$$

The relative probability of $Y_i = 1|\mathbf{x}_i$ to the base outcome is:

$$\frac{\text{Prob}(Y_i = 1|\mathbf{x}_i)}{\text{Prob}(Y_i = 0|\mathbf{x}_i)} = e^{\mathbf{x}_i'\boldsymbol{\beta}_1}$$

By differentiating (2), the marginal effects of the characteristics on the probabilities are written as:

---

[51] Multinomial logit model is also known as polychotomous logistic regression model. Sometimes conditional logistic regression is also referred as a multinomial logit, but it is treated as a different model in this study.

$$\frac{\partial P_j}{\partial \mathrm{x}_i} = \frac{\beta_j e^{\mathbf{x}_i'\boldsymbol{\beta}_j}\left(1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}\right) - e^{\mathbf{x}_i'\boldsymbol{\beta}_j} \sum_{k=1}^{J} \beta_k e^{\mathbf{x}_i'\boldsymbol{\beta}_k}}{\left(1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}\right)^2}$$

$$= \frac{e^{\mathbf{x}_i'\boldsymbol{\beta}_j}}{1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}} \left\{ \frac{\beta_j\left(1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}\right) - \sum_{k=1}^{J} \beta_k e^{\mathbf{x}_i'\boldsymbol{\beta}_k}}{1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}} \right\}$$

$$= P_j \left\{ \beta_j - \frac{\sum_{k=1}^{J} \beta_k e^{\mathbf{x}_i'\boldsymbol{\beta}_k}}{1 + \sum_{k=1}^{J} e^{\mathbf{x}_i'\boldsymbol{\beta}_k}} \right\}$$

$$= P_j \left\{ \beta_j - \sum_{k=0}^{J} \beta_k P_k \right\} \qquad \because \beta_0 = 0$$

Therefore, the marginal effect is affected by every subvector of $\beta$.

## 3.6 Results

An analysis of U.S. household's probability of purchasing omega-3 eggs between 1998 and 2007, based on AC Nielsen Homescan® data, is conducted using logistic regression, probit regression, and multinomial logistic regression methods. The explanatory variables of interest are indices of media information about the health and developmental benefits of increasing omega-3 fatty acids in the human diets, in addition to other household demographics or regional differences.

### 3.6.1 Logit

A logistic regression is conducted for the households that bought eggs in each month. If the household did not buy any eggs in a given month, their data for the month are omitted from the sample. The number of observations used in the logistic regression is 1,565,320. The results from the logit model using the media index for the information

**Table 14 Estimates from Logit with Media Index for Omega-3 Health Benefits**

| | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.14604 | *** | 0.01340 | -0.00502 | *** | 0.00045 |
| Household Income ($1,000) | 0.00625 | *** | 0.00035 | 0.00021 | *** | 0.00001 |
| Age of Household Head | 0.01172 | *** | 0.00136 | 0.00040 | *** | 0.00005 |
| Education of Household Head (D) | 0.17372 | *** | 0.03078 | 0.00612 | *** | 0.00111 |
| Major Market (D) | 0.09629 | *** | 0.03091 | 0.00329 | *** | 0.00105 |
| East (D) | 0.22440 | *** | 0.03850 | 0.00828 | *** | 0.00152 |
| Central (D) | -0.51283 | *** | 0.04260 | -0.01576 | *** | 0.00117 |
| West (D) | -0.20990 | *** | 0.04277 | -0.00682 | *** | 0.00131 |
| Spring (D) | 0.04602 | *** | 0.01532 | 0.00160 | *** | 0.00054 |
| Fall (D) | 0.06185 | *** | 0.01153 | 0.00216 | *** | 0.00040 |
| Winter (D) | -0.01173 | | 0.01511 | -0.00040 | | 0.00052 |
| Regular Egg Price (dozen, $) | 0.24051 | *** | 0.01903 | 0.00827 | *** | 0.00067 |
| Omega Egg Price (dozen, $) | 0.21599 | | 0.13676 | 0.00743 | | 0.00468 |
| Regular Egg Deal (D) | -1.38161 | *** | 0.02668 | -0.03718 | *** | 0.00074 |
| Current Media Index for Health | 0.01006 | *** | 0.00082 | 0.00035 | *** | 0.00003 |
| Constant | -4.63527 | *** | 0.30067 | | | |

The number of observations is 1,565,320.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,513 clusters in households.

about “omega-3 is good for your health” are displayed in Table 14. The media index is the one in the current period.[52] The standard errors are adjusted for 84,420 clusters (households).[53]

The explanatory variables are selected by looking at the significance of the Wald test.[54] For example, variables such as the presence of children, race, and Hispanic are not included in the model because each of these variables is insignificant in the result and also insignificant by the Wald test which jointly tests the significance of the variables.

The coefficient on household size is negative and significant. The marginal effect shows that if the household size increases by one, the probability of buying omega-3 eggs, conditional on buying some eggs, decreases by 0.5% at the sample mean (2.45). Larger households spend more money on food, so they may think price is a more important factor in choosing from among the alternatives. In general, omega-3 eggs have much higher prices than regular eggs. Other things equal, larger households are less likely to buy omega-3 eggs.

The coefficient on household income is positive. If the household income increases by $1,000, the probability of buying omega-3 eggs, conditional on buying some eggs, increases by 0.02% at the sample mean ($55,150). This result is consistent with the survey by Mintel (2008), which concluded that household income is the strongest factor affecting the purchase of omega-3 enriched eggs.

---

[52] $S_t$ in subsection 3.3.4.

[53] Clustering by time period (120 clusters) is also conducted for comparison. In that case, the current media index for health is still significant at the 1% level with the standard error 0.00120.

[54] See subsection 3.5.1. for the Wald test.

The age of household head also has a positive relationship. Increasing the age of household head by one year increases the probability of buying omega-3 eggs, conditional on buying some eggs, by 0.04% at the sample mean (52.61). This result is also consistent with previous studies, such as Chase et al. (2007), which suggest that the elderly are more likely to purchase omega-3 products.

The education of the household head has a positive effect as well. If the head of household has a college degree, the probability of buying omega-3 eggs, conditional on buying some eggs, increases by 0.6%. This result agrees with the study by Chase et al. (2007), which proposed a positive relationship between educational attainment and omega-3 purchase frequency.

If the households live in a major market (urban area) as defined by ACNielsen, the probability of buying omega-3 eggs, conditional on buying some eggs, increases by 0.3%. People living in urban areas may have easier access to the information on omega-3 eggs and to the new products available on the market, compared to the people living in rural area.

The U.S. is divided into four regions: south, east, west, and central. The southern region has the biggest population in the data so they are selected to be the base. The regional variables are jointly tested using the Wald test and are found to be significantly different from the Southern region. Compared to people in the southern region, people in the east are more inclined to buy omega-3 eggs. On the contrary, people in the central and west are less likely to buy omega-3 eggs. These results are somewhat unexpected because the south is often considered to be a relatively conservative region and slower to adopt new ideas, especially relative to the western region.

To account for the seasonal impact, the summer dummy variable is used as a base. The Wald test for these seasonal dummies is jointly significant; spring and fall have positive coefficients indicating that these eggs are more likely to be purchased in spring and fall, compared to summer.[55]

Egg prices for both regular eggs and omega-3 eggs are included in the model.[56] The price of regular eggs has a positive effect on omega-3 eggs purchase. If the price of a dozen regular eggs increases by $1, the probability of buying omega-3 eggs, conditional on buying some eggs, increases by 0.8% at the sample mean ($1.21). If the regular egg's price goes up, the price difference between regular eggs and omega-3 eggs shrinks, which induces consumers to choose omega-3 eggs. As basic economic theory states, the substitution effect causes consumers to purchase less of the relatively inexpensive good (regular eggs) and more of a substitute good (omega-3 eggs) as the price of the original good (regular eggs) rises.

On the other hand, the price of omega-3 eggs does not have a significant effect on omega-3 eggs purchase. The coefficient even shows a positive sign though not

---

[55] For the statistics of egg prices and share of omega-3 eggs by season, see subsection 3.2.2.

[56] The prices are from the ACNielsen Homescan® data and represent the prices actually paid by the household, so the price is either for the regular eggs purchased or the omega-3 eggs purchased. Hence, for the prices which are not in the record for the household are calculated as monthly average prices. For example, if the household A bought regular eggs for $2 in January 2000 but did not buy any omega-3 eggs, the record for household A in January 2000 does not have the information on omega-3 eggs' price that household A faced in January 2000. So, the omega-3 eggs price from all of the households who bought omega-3 eggs in January 2000 are averaged and put it as household A's omega-3 eggs price in January 2000.

significant. Consumers are not very sensitive to a change in the price of omega-3 eggs. It can be said that consumers who choose to buy omega-3 eggs are not simply looking for low prices but instead are looking for something else, namely characteristics of the product that promise to improve their health.

The dummy variable “Regular Egg Deal” shows whether eggs are bought during a month when the retailer reduced the price of regular eggs (=1) or if the price was the ordinary price of regular eggs (=0).[57] When regular eggs are on sale, the purchase of omega-3 eggs, conditional on buying some eggs, decreases by 3.7%. In fact, this is the largest marginal change of all the variables in the model. This probability of purchasing omega-3 eggs is not sensitive to the price of omega-3 eggs, but a larger differential between the price of omega-3 eggs and regular eggs, drives consumers to decrease their purchases of omega-3 eggs.

The correlation between the regular egg deal variable and regular egg price variable is negative, -0.1856. It does not correlate much. It is considered that they have different role on consumers’ choice. Because the deal is temporary, it urges consumers to buy it now compared to a low price all the time.

The main variable of interest, the media index, is statistically significant at the 1% level. If the media index for information about the health effects of omega-3 increases by one unit, the probability of buying omega-3 eggs, conditional on buying some eggs, increases by 0.04% at the sample mean (22.2). It suggests that the media

[57] The omega-3 eggs deal dummy variable is created in the same way; however, it is not used because it accounts for only 1.4% of the observations, and including it does not have enough power to make much difference in estimation.

index has a positive effect on consumers' purchase choices. Note that this one unit is not directly associated with the number of articles published since the index is constructed through content analysis, standardization, and weighting the information sources.[58]

When time trend is added in this regression, both the time trend and the media index are positively significant at the 1% level.[59] The correlation between the media index and the time trend is 0.5909. It is no wonder that time plays a role on consumers' choice because their knowledge on nutritional information accumulates over time. At the same time, however, the consumers' choice is not only affected by time but also by the media index.

One might argue that all of the above marginal effects are very small. The relation of the logit probability (*P*) to representative utility (*V*) is sigmoid, or S-shaped, as shown in Figure 6. This shape has implications for the impact of changes in explanatory variables. If the representative utility of an alternative is very low (or very high) compared with other alternatives, a small increase in the utility of the alternative has little effect on the probability of its being chosen: the other alternatives are still sufficiently better (worse) such that this small improvement doesn't help much. The point at which the increase in representative utility has the greatest effect on the probability of its being chosen is when the probability is close to 0.5 (Train, 2003). In this study, the percentage of consumers who chose omega-3 eggs is small and not close

[58] See section 3.3 for detail.

[59] Time trend starts with 1 for the first month, 2 for the second month, and so on.

to 50%.[60] This small probability of omega-3 eggs purchase contributes to the results of subtle impact.

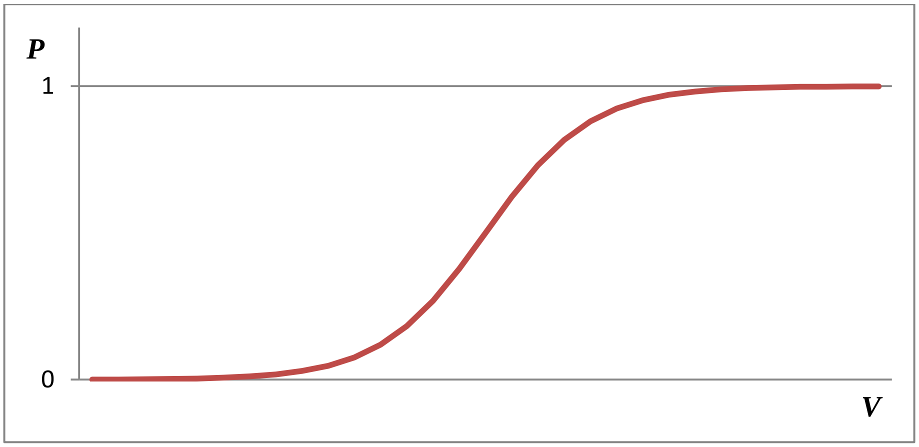



**Figure 6 Graph of Logit Curve**

### 3.6.2 Effect of Media in the Past

The effect of mass media coverage is expected to be cumulative, extending back several months (Verbeke and Ward, 2001). Consumers may be influenced by the articles in previous periods as well. To capture the accumulating impact of articles, two kinds of media indexes are used. One is the discounted media index (MI) which assumes 20 % information decay by a month, as Kim and Chern (1999) concluded as the best specification, and consists of media index for six months.[61] The other is the cumulative

[60] See subsection 3.2.2.
[61] See subsections 3.1.2 and 3.3.4 for detail. Discounted MI corresponds to $T_t$ in 3.3.4.

index, which is a summation of the media index from the first month to the previous period as Chang and Just (2007) used.

The estimation with the discounted media index is shown in Table 15. The discounted media index (MI) is statistically significant at the 1% level. If the media index for information about the health effects of omega-3 increases by one unit, the probability of buying omega-3 eggs, conditional on buying some eggs, increases by

**Table 15 Estimates from Logit with Discounted Media Index for Omega-3 Health Benefits**

| | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.14764 | *** | 0.01353 | -0.00508 | *** | 0.00046 |
| Household Income ($1,000) | 0.00622 | *** | 0.00035 | 0.00021 | *** | 0.00001 |
| Age of Household Head | 0.01100 | *** | 0.00137 | 0.00038 | *** | 0.00005 |
| Education of Household Head (D) | 0.17735 | *** | 0.03083 | 0.00625 | *** | 0.00111 |
| Major Market (D) | 0.12502 | *** | 0.03073 | 0.00426 | *** | 0.00104 |
| East (D) | 0.24259 | *** | 0.03851 | 0.00901 | *** | 0.00154 |
| Central (D) | -0.51861 | *** | 0.04269 | -0.01592 | *** | 0.00116 |
| West (D) | -0.18862 | *** | 0.04262 | -0.00616 | *** | 0.00132 |
| Spring (D) | 0.01953 | | 0.01853 | 0.00067 | | 0.00064 |
| Fall (D) | 0.12656 | *** | 0.00994 | 0.00448 | *** | 0.00036 |
| Winter (D) | 0.01531 | | 0.01551 | 0.00053 | | 0.00054 |
| Regular Egg Price (dozen, $) | 0.21295 | *** | 0.01790 | 0.00732 | *** | 0.00062 |
| Omega Egg Price (dozen, $) | -0.06330 | | 0.18694 | -0.00218 | | 0.00643 |
| Regular Egg Deal (D) | -1.37588 | *** | 0.02703 | -0.03705 | *** | 0.00076 |
| Discounted MI for Health | 0.00593 | *** | 0.00053 | 0.00020 | *** | 0.00002 |
| Constant | -4.32704 | *** | 0.38449 | | | |

The number of observations is 1,541,638.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,420 clusters in households.

0.02%. The media index which accounts for the information decay has a positive effect on consumers' purchase choices, but the impact is smaller compared to the previous estimation which uses the media index of only the current period. The impacts of other variables are similar to the previous model except seasonal dummy variables. All seasonal variables have positive coefficients indicating that these eggs are less likely to be purchased in the summer time; however, it is not straightforward to interpret why the probability of buying omega-3 eggs increases significantly in fall.

Table 16 on the next page shows the results from a logit regression in which the media index for the current month ($S_t$) and the accumulation of the index up to the previous month ($\sum_{t=1}^{t-1} S_t$) are included. The correlation of these two variables is 0.56, and yet both of the media indexes are significantly positive at the 1% level. A one unit increase in the current media index increases the probability of purchasing omega-3 eggs by ten times more than the one unit increase in the past information.

This method of including both current and cumulative media index is the same as the study by Chang and Just (2007), which concluded that health information will decay to a point of unimportance in a matter of a few weeks, which means that the information in the current period is much more important than that in the previous period. However, the accumulated information still plays a role in choosing the omega-3 eggs, and it can be argued that the current information would not have the same impact in the absence of prior exposure to similar information.

**Table 16 Estimates from Logit with Current and Cumulative Media Index for Omega-3 Health Benefits**

| | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.15081 | *** | 0.01358 | -0.00508 | *** | 0.00045 |
| Household Income ($1,000) | 0.00624 | *** | 0.00036 | 0.00021 | *** | 0.00001 |
| Age of Household Head | 0.01080 | *** | 0.00137 | 0.00036 | *** | 0.00005 |
| Education of Household Head (D) | 0.18291 | *** | 0.03080 | 0.00633 | *** | 0.00109 |
| Major Market (D) | 0.15553 | *** | 0.03064 | 0.00519 | *** | 0.00101 |
| East (D) | 0.25781 | *** | 0.03829 | 0.00943 | *** | 0.00152 |
| Central (D) | -0.52988 | *** | 0.04269 | -0.01591 | *** | 0.00113 |
| West (D) | -0.17108 | *** | 0.04223 | -0.00551 | *** | 0.00130 |
| Spring (D) | 0.09517 | *** | 0.01434 | 0.00328 | *** | 0.00050 |
| Fall (D) | 0.04881 | *** | 0.01328 | 0.00166 | *** | 0.00046 |
| Winter (D) | 0.06174 | *** | 0.01186 | 0.00211 | *** | 0.00041 |
| Regular Egg Price (dozen, $) | 0.16315 | *** | 0.01531 | 0.00550 | *** | 0.00052 |
| Omega Egg Price (dozen, $) | -0.28259 | | 0.22584 | -0.00953 | | 0.00761 |
| Regular Egg Deal (D) | -1.37135 | *** | 0.02715 | -0.03623 | *** | 0.00076 |
| Current MI for Health | 0.00298 | *** | 0.00037 | 0.00010 | *** | 0.00001 |
| Cumulative MI for Health | 0.00039 | *** | 0.00004 | 0.00001 | *** | 0.00000 |
| Constant | -3.83052 | *** | 0.46248 | | | |

The number of observations is 1,565,320.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,513 clusters in households.

### 3.6.3 Developmental Benefits

The results mentioned above use the media index for information about omega-3's health benefits. Similarly, regressions which use that about developmental benefits are conducted. Table 17 shows the results from a logistic regression with the media index of the current period for the message that "omega-3 is good for your development."

**Table 17 Estimates from Logit with Media Index for Omega-3 Developmental Benefits**

| | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.14868 | *** | 0.01347 | -0.00509 | *** | 0.00045 |
| Household Income ($1,000) | 0.00625 | *** | 0.00035 | 0.00021 | *** | 0.00001 |
| Age of Household Head | 0.01170 | *** | 0.00136 | 0.00040 | *** | 0.00005 |
| Education of Household Head (D) | 0.17814 | *** | 0.03080 | 0.00626 | *** | 0.00110 |
| Major Market (D) | 0.12008 | *** | 0.03081 | 0.00408 | *** | 0.00104 |
| East (D) | 0.23102 | *** | 0.03847 | 0.00851 | *** | 0.00152 |
| Central (D) | -0.52143 | *** | 0.04270 | -0.01593 | *** | 0.00116 |
| West (D) | -0.19528 | *** | 0.04254 | -0.00634 | *** | 0.00131 |
| Spring (D) | 0.09717 | *** | 0.01310 | 0.00340 | *** | 0.00047 |
| Fall (D) | -0.06424 | *** | 0.01892 | -0.00217 | *** | 0.00063 |
| Winter (D) | 0.00669 | | 0.01403 | 0.00023 | | 0.00048 |
| Regular Egg Price (dozen, $) | 0.20386 | *** | 0.01741 | 0.00698 | *** | 0.00061 |
| Omega Egg Price (dozen, $) | 0.13556 | | 0.14839 | 0.00464 | | 0.00507 |
| Regular Egg Deal (D) | -1.37530 | *** | 0.02680 | -0.03690 | *** | 0.00074 |
| Current MI for Development | 0.01038 | *** | 0.00085 | 0.00036 | *** | 0.00003 |
| Constant | -4.40022 | *** | 0.32793 | | | |

The number of observations is 1,565,320.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,420 clusters in households.

The results are quite similar to the results in Table 14. The media index is significant as well. In the same way as health benefits, regressions which include past media index for developmental benefits are conducted, but there are not noteworthy differences from the regressions with the media index for health benefits.

The developmental benefit applies to babies, children, and pregnant women in particular so it is expected that young households or households with children would be more sensitive to the information on the developmental benefits of omega-3. Several regressions are tried to see the difference that the presence of children or the stage of their life might make in their purchase decisions.[62] None of the results have convincing evidence for such a tendency. From these results, one can conclude that people are paying attention to the overall positive message, "omega-3 is good for your health", than the targeted message about developmental benefit.

### 3.6.4 Comparison with Probit

As stated earlier, a probit regression model is also popular for analyzing discrete choice models. It has a different assumption on the error term distribution, i.e., it assumes a normal distribution instead of a logistic distribution. Though this study treats the logit model as a preferred model, the estimation results from the probit model with the media index for health are provided in Table 18 on the next page for comparison.

[62] For instance, estimating with a presence of children dummy variable, estimating by selecting the subsample which has the age of household head is less than 45 years old, and estimating by selecting subsample with children.

**Table 18 Estimates from Probit with Media Index for Omega-3 Health Benefits**

| | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.06720 | *** | 0.00605 | -0.00540 | *** | 0.00048 |
| Household Income ($1,000) | 0.00302 | *** | 0.00017 | 0.00024 | *** | 0.00001 |
| Age of Household Head | 0.00558 | *** | 0.00062 | 0.00045 | *** | 0.00005 |
| Education of Household Head (D) | 0.08202 | *** | 0.01431 | 0.00673 | *** | 0.00120 |
| Major Market (D) | 0.04472 | *** | 0.01401 | 0.00357 | *** | 0.00111 |
| East (D) | 0.10757 | *** | 0.01833 | 0.00922 | *** | 0.00167 |
| Central (D) | -0.23315 | *** | 0.01888 | -0.01691 | *** | 0.00123 |
| West (D) | -0.09979 | *** | 0.01956 | -0.00760 | *** | 0.00141 |
| Spring (D) | 0.01242 | * | 0.00523 | 0.00100 | * | 0.00042 |
| Fall (D) | 0.02226 | *** | 0.00468 | 0.00181 | *** | 0.00038 |
| Winter (D) | -0.01520 | *** | 0.00551 | -0.00121 | *** | 0.00044 |
| Regular Egg Price (dozen, $) | 0.13879 | *** | 0.00870 | 0.01115 | *** | 0.00070 |
| Omega Egg Price (dozen, $) | 0.00807 | | 0.03229 | 0.00065 | | 0.00259 |
| Regular Egg Deal (D) | -0.59142 | *** | 0.01088 | -0.03794 | *** | 0.00075 |
| Current Media Index for Health | 0.00520 | *** | 0.00028 | 0.00042 | *** | 0.00002 |
| Constant | -2.27353 | *** | 0.07987 | | | |

The number of observations is 1,565,320.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,513 clusters in households.

The results are similar to the results from the logit model (Table 14). The sign and magnitude of marginal effects and their statistical significance are almost the same.[63] One exception would be the significance of seasonal variables, which is hard to interpret.

[63] To compare the coefficients, we might expect to obtain comparable estimates by multiplying the probit coefficients by $\pi/\sqrt{3}\approx 1.8$ because the variances of the distributions, one for the normal and $\pi^2/3$ for the logistic, are different. Amemiya (1981) found, through trial and error, that scaling by 1.6 instead produced better results. This proportionality result is frequently cited (Greene, 2003).

### 3.6.5 Difference in Media Types

Thus far the media index is the aggregated index of various media types. Another regression with three media indexes categorized by the media type is conducted to see the influence from each media type (Table 19).

**Table 19 Estimates from Logit with Three Media Indexes for Omega-3 Health Benefits**

| | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.14591 | *** | 0.01341 | -0.00501 | *** | 0.00045 |
| Household Income ($1,000) | 0.00625 | *** | 0.00035 | 0.00021 | *** | 0.00001 |
| Age of Household Head | 0.01158 | *** | 0.00136 | 0.00040 | *** | 0.00005 |
| Education of Household Head (D) | 0.17385 | *** | 0.03079 | 0.00612 | *** | 0.00111 |
| Major Market (D) | 0.09652 | *** | 0.03093 | 0.00329 | *** | 0.00105 |
| East (D) | 0.22672 | *** | 0.03849 | 0.00836 | *** | 0.00152 |
| Central (D) | -0.51283 | *** | 0.04259 | -0.01573 | *** | 0.00116 |
| West (D) | -0.20933 | *** | 0.04279 | -0.00679 | *** | 0.00131 |
| Spring (D) | 0.00674 | | 0.01814 | 0.00023 | | 0.00062 |
| Fall (D) | 0.03502 | *** | 0.01322 | 0.00121 | *** | 0.00046 |
| Winter (D) | -0.01404 | | 0.01569 | -0.00048 | | 0.00054 |
| Regular Egg Price (dozen, $) | 0.24110 | *** | 0.01910 | 0.00828 | *** | 0.00067 |
| Omega Egg Price (dozen, $) | 0.18768 | | 0.14197 | 0.00644 | | 0.00486 |
| Regular Egg Deal (D) | -1.38195 | *** | 0.02668 | -0.03713 | *** | 0.00074 |
| Current MI for Health in Newspapers | 0.00562 | *** | 0.00050 | 0.00019 | *** | 0.00002 |
| Current MI for Health in Transcripts | 0.00256 | *** | 0.00027 | 0.00009 | *** | 0.00001 |
| Current MI for Health in Magazines | 0.00264 | *** | 0.00024 | 0.00009 | *** | 0.00001 |
| Constant | -4.60281 | *** | 0.30992 | | | |

The number of observations is 1,565,320.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,513 clusters in households.

Three media indexes are for: a) newspapers and newswires (newspapers in the table), b) TV and radio (transcripts in the table), and c) magazines. These three media indexes are used together in one regression. These are scored and standardized, but skipped the aggregation by weighting.[64]

All media indexes are significant. Among them, media index from newspapers and newswires has the largest effect on omega-3 eggs purchase. One reason would be the data issue. LexisNexis® has more comprehensive coverage on newspapers than other media. Accordingly, the total number of newspaper articles is larger than other media. The large volume of the articles makes the change relatively clear.

### 3.6.6 Multinomial Logit

A multinomial logistic regression is estimated for all households, including households that did not buy any eggs in the month.[65] The number of observation used is 2,488,964. The standard errors are adjusted for 84,513 clusters (households). As with the previous models, the included variables are selected by looking at the significance and the results of the Wald test. Unlike the logit model, the presence of children, and the Hispanic, Black, and Asian variables are included due to their statistical significance.

The results from the multinomial logit model with the current period media index with the message "omega-3 is good for your health" are displayed in Table 20. An

[64] See subsection 3.3.4 for detail of construction. Also, the actual values are provided in Appendix E and F.
[65] Again, the households that did not buy eggs in a given year (about 5%, see subsection 3.2.2 for detail) are excluded from the sample.

important feature of the multinomial logit model is that it estimates *k-1* set of parameter estimates, where *k* is the number of values taken by the dependent variable. The reference group is the purchase of regular eggs only. The two sets of estimators show what variables increase the probability of: no egg purchases in a month (relative to purchasing regular eggs) and the purchase of omega-3 eggs (relative to purchasing regular eggs).[66]

**Table 20 Estimates from Multinomial Logit with Media Index for Omega-3 Health Benefits**

| [No Purchase of Eggs] | Coefficient | | S.E. | Marginal Effect | | S.E. |
|---|---|---|---|---|---|---|
| Household Size | -0.20231 | *** | 0.00483 | -0.00030 | *** | 0.00001 |
| Household Income ($1,000) | -0.00046 | *** | 0.00012 | 0.00000 | *** | 0.00000 |
| Age of Household Head | -0.01154 | *** | 0.00039 | -0.00002 | *** | 0.00000 |
| Education of Household Head (D) | 0.15362 | *** | 0.00941 | 0.00022 | *** | 0.00001 |
| Presence or Children (D) | 0.04494 | *** | 0.01358 | 0.00007 | *** | 0.00002 |
| Hispanic (D) | -0.07231 | *** | 0.01772 | -0.00011 | *** | 0.00002 |
| Black (D) | 0.20133 | *** | 0.01467 | 0.00033 | *** | 0.00003 |
| Asian (D) | 0.15887 | *** | 0.03235 | 0.00025 | *** | 0.00006 |
| Major Market (D) | 0.15534 | *** | 0.00904 | 0.00022 | *** | 0.00001 |
| East (D) | 0.29825 | *** | 0.01319 | 0.00048 | *** | 0.00002 |
| Central (D) | 0.14253 | *** | 0.01149 | 0.00025 | *** | 0.00002 |
| West (D) | 0.39210 | *** | 0.01251 | 0.00068 | *** | 0.00002 |
| Spring (D) | -0.06605 | *** | 0.00375 | -0.00010 | *** | 0.00001 |
| Fall (D) | -0.03599 | *** | 0.00372 | -0.00006 | *** | 0.00001 |

[66] The relationship between the probability of no purchase of eggs and that of omega-3 eggs purchase can be calculated as well. The relative probability of purchase of omega-3 eggs relative to no egg purchase in the month is $e^{x\beta(2)}/e^{x\beta(0)}$ , where β(0) is the log-odds for no purchase relative to regular eggs purchase and β(2) is the log-odds for omega-3 purchase relative to regular eggs purchase.

| | | | | | | |
|---|---|---|---|---|---|---|
| Winter (D) | -0.11145 | *** | 0.00413 | -0.00016 | *** | 0.00001 |
| Regular Egg Price (dozen, $) | -0.37476 | *** | 0.01040 | -0.00058 | *** | 0.00002 |
| Omega Egg Price (dozen, $) | 0.26372 | *** | 0.01432 | 0.00038 | *** | 0.00002 |
| Regular Egg Deal (D) | -39.25869 | *** | 0.00972 | -0.45634 | *** | 0.00111 |
| Current Media Index for Health | 0.00017 | | 0.00014 | 0.00000 | | 0.00000 |
| Constant | 0.55543 | *** | 0.04043 | | | |
| [Omega-3 Egg Purchase] | | | | | | |
| Household Size | -0.11907 | *** | 0.01595 | -0.00465 | *** | 0.00062 |
| Household Income ($1,000) | 0.00592 | *** | 0.00035 | 0.00023 | *** | 0.00001 |
| Age of Household Head | 0.01104 | *** | 0.00141 | 0.00043 | *** | 0.00006 |
| Education of Household Head (D) | 0.17579 | *** | 0.03076 | 0.00702 | *** | 0.00125 |
| Presence or Children (D) | -0.07730 | | 0.04750 | -0.00298 | | 0.00180 |
| Hispanic (D) | 0.02759 | | 0.05800 | 0.00110 | | 0.00232 |
| Black (D) | -0.09383 | * | 0.05653 | -0.00356 | * | 0.00206 |
| Asian (D) | 0.05426 | | 0.09606 | 0.00217 | | 0.00394 |
| Major Market (D) | 0.10937 | *** | 0.03140 | 0.00424 | *** | 0.00121 |
| East (D) | 0.22417 | *** | 0.03863 | 0.00938 | *** | 0.00173 |
| Central (D) | -0.51706 | *** | 0.04273 | -0.01808 | *** | 0.00133 |
| West (D) | -0.21106 | *** | 0.04291 | -0.00784 | *** | 0.00150 |
| Spring (D) | 0.05246 | *** | 0.02028 | 0.00208 | *** | 0.00081 |
| Fall (D) | 0.06089 | *** | 0.01319 | 0.00242 | *** | 0.00053 |
| Winter (D) | -0.01425 | | 0.01924 | -0.00055 | | 0.00075 |
| Regular Egg Price (dozen, $) | 0.33301 | *** | 0.02521 | 0.01306 | *** | 0.00099 |
| Omega Egg Price (dozen, $) | 0.31038 | | 0.20432 | 0.01214 | | 0.00797 |
| Regular Egg Deal (D) | -1.36672 | *** | 0.02669 | -0.01407 | *** | 0.00045 |
| Current Media Index for Health | 0.00936 | *** | 0.00106 | 0.00037 | *** | 0.00004 |
| Constant | -4.94407 | *** | 0.43415 | | | |

The number of observations is 2,488,964.
(D) indicates dummy variable. Their marginal effects are for discrete change from 0 to 1.
***: significant at the 1% level.
The standard errors are adjusted for 84,513 clusters in households.

(1) No purchase relative to regular eggs purchase

In this multinomial logit specification, the log-odds and marginal effects for no purchase relative to regular eggs purchase are presented as coefficients in the upper half of Table 20. If the coefficient is *positive*, given the other variables in the model are held constant, they are likely to choose *not* to buy eggs rather than to buy regular eggs with increase in the variable.

The variables that contribute to the decision to buy regular eggs relative to no purchase are household size, income, household head's age, Hispanic, seasonal dummies (compared to the summer) for spring, fall, winter, increase in regular eggs price and regular eggs deal. Among them, the most influential variable is the regular egg deal. If the regular eggs are on sale, households increase the chance to buy regular eggs by 45% relative to no purchase. The impacts of other variables are small. Though the effect is small, the result that they tend to buy regular eggs instead of not to buy eggs as the regular price increases seems somewhat inconsistent with the laws of consumer economic demand.[67]

The variables that contribute to the decision not to buy eggs instead of buying regular eggs are household education, presence of children, black, Asian, major market, regional dummies for east, central, west and omega-3 egg price. The media index has a positive impact, but it is negligibly small. The media index conveys the health

[67] The law of demand states that consumers buy more of a good when its price decreases and less when its price increases.

information on omega-3 fatty acids and therefore it has little or nothing to do with the decision to buy regular eggs or not.

(2) Omega-3 eggs purchase relative to regular eggs purchases

The results in the bottom of Table 20 shows the log-odds and marginal effects of omega-3 eggs purchase relative to regular eggs purchase. Compared to the logit estimation (Table 14), the results are quite similar. Added variables (presence of children, Hispanic, Black, and Asian) are not significant for the estimation. The media index is still strongly significant.

## 3.7 Key Findings

The Media Index, the main variable of interest, has a significantly positive impact on purchases of omega-3 eggs in every model. This result implies that consumers obtain new scientific nutritional knowledge through popular media and consumers' purchase choices reflect their knowledge of new nutritional information and its connection with food.

This study incorporated the effect of time by specifying a discounted media index, which reflects the presumed delayed impact of messages. In another model which employed two media indices, the media index for the current month and the accumulation of that index up to the previous month, the information in the current period seemed to be more important than that in previous period. But still, the stock of knowledge or beliefs in consumers' minds plays a role in food choice. It can be argued that the current information would not have the same impact in the absence of prior exposure to similar information.

The model with the media index for the information about omega-3's health benefits and the model with the media index for the information about their developmental benefits produce quite similar results. Though developmental benefits are expected to be attractive to the households with children, there is no convincing evidence for such a tendency. It may be hard to reach the intended consumers with targeted messages.

Household demographics clearly have impacts on consumers' food choices. Higher household income, age of head, and education has positive relationships with the probability of purchasing omega-3 eggs. Higher income might diminish their hesitation against higher prices of omega-3 eggs; elderly people tend to pay more attention to their health; and higher education may indicate higher information literacy. Household size had a negative relationship with omega-3 eggs' purchase probably because larger households have to allocate their money for food over more household members, so the price becomes a more important factor for them in choosing from among the alternatives.

If households are living in an urban area, the probability of buying omega-3 eggs increases. People living in urban areas may have easier access to the information and to the new products available on the market. Compared to people in the southern region, people in the East are more likely and people in central or West are less likely, to buy omega-3 eggs. These results are somewhat unexpected because the South is often considered to be a relatively conservative region and that is slower to adopt new ideas.

One of the interesting findings is the consumers' behavior toward the price of eggs. Consumers are quite sensitive to the prices of regular eggs. If the price of regular eggs decreases, the price difference between regular eggs and omega-3 eggs widens and discourages consumers from choosing omega-3 eggs. In fact, whether the regular eggs are on sale or not causes the largest marginal change of all the variables in the model. On the other hand, consumers are not very sensitive to a change in the price of omega-3 eggs. Omega-3 fatty acids' characteristics that promise to improve consumers' health seem to have a stronger impact than price on purchase choice of omega-3 eggs.

There are no noteworthy differences between the three popular empirical models: logit, probit, and multinomial logit. The results from the probit model are similar to those from the logit model: The sign and magnitude of marginal effects and their significance are almost the same. The results of multinomial logit are also similar to those of other models in terms of the impact of explanatory variables on omega-3 eggs purchases.

# 4. Part II Welfare Analysis

In this section, the consumer welfare change from 1998 to 2007 is analyzed based on the AC Nielsen Homescan® data. In addition to the measurement of the change of the consumer surplus, the value of information (or the cost of ignorance) is calculated following the theoretical framework of Foster and Just (1989) and Teisl et al. (2001).

## 4.1 Theoretical Framework

### 4.1.1 Imperfect Information and Utility

A consumer is assumed to allocate a fixed budget to a bundle of goods based on known prices, a set of information about the goods, and their perception of the utility to be derived from consumption. If the consumer's knowledge about the goods in the consumption bundle is inaccurate at the time of budget allocation, the utility actually realized from consumption will differ from the utility previously perceived (Kinsey et al., 1980).

Figure 7 illustrates their perceived, realized, and optimal utility. $U_p$ represents the consumer's previously perceived indifference curve between goods $x_1$ and $x_2$. $U_r$ is the consumer's realized indifference curve and $U^*$ is the optimal one. If they have a perfect information, they will choose to consume the bundle B ($x_1^*$,$x_2^*$), which yields the maximum utility obtainable with the complete (true) information. However, they choose to consume the bundle A ($x_1^0$,$x_2^0$) under imperfect information. The utility realized at A is actually less than the maximum utility obtainable with complete information ($U^*$> $U_r$).

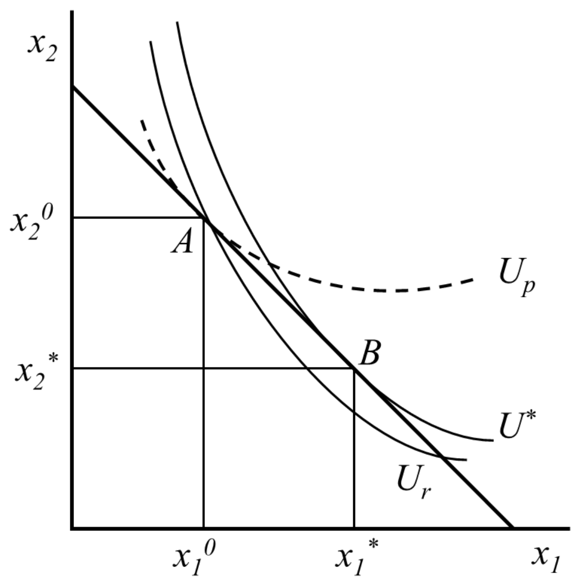



**Figure 7 Perceived, Realized, and Optimal Utility**

Note that in this scheme, new information changes the shape of the indifference curve. One cannot compare the welfare between point A on $U_p$ to the point B on U*, but one can compare the welfare on point A on $U_r$ and point B on U*. In this study, the two bundles of goods are omega-3 eggs and regular eggs, and health benefits of omega-3 eggs are considered to be new information.

### 4.1.2 Value of Information (Cost of Ignorance)

When relevant information on products is unknown or withheld, consumers are unable to change their behavior, though they would change their behavior if they had the information. It is a specific cost borne by consumers, namely the cost of ignorance (COI) (Foster and Just, 1989). The COI approach is the converse of the value of information (VOI) approach and both have great relevance for evaluating welfare effects of information. This study mainly follows the conceptual framework of Foster and Just (1989) and Teisl et al. (2001). Teisl et al. applied Foster and Just's contamination information framework to nutritional information.

The consumer's utility function is represented by $U(x, \theta, z)$, where $x$ is the good of interest, $\theta$ is its subjective estimate of its quality distribution, and $z$ is a numeraire good.[68] The individual chooses $x$ and $z$ to maximize his expected utility, given by

$$\max_{x,z} E_\theta[U(x,\theta,z)] \quad \text{subject to} \quad z + px = y$$

where $E_\theta$ is an expectation with respect to the quality distribution, $p$ is the price of $x$ relative to the price of other goods, and $y$ is income relative to the price of other goods. When this problem is solved, the solution can be represented by Marshallian demand function given by $x^* = f(p, y, \theta)$. This defines an expected indirect utility function

[68] The contamination case (Foster and Just, 1989) differentiated between the quality level and its distribution. In their construct, quality level enters the utility function and consumer maximizes the expected utility with respect to the quality distribution.

$\overline{U} = V(p, y, \theta)$, whose inverse is the expenditure function $y = e(p, \overline{U}, \theta)$.[69] These relationships are shown in Appendix G.

However, there is a paradox in this problem. If an individual does not update $\theta$ according to the new information, he will not alter his behavior. Then he will appear to have no measured welfare loss. Foster and Just (1989) resolved this paradox by measuring the welfare change associated with information in a different way.

In their formulation, compensating variation (CV) is used to measure the welfare change of the consumer.[70] CV measures a consumer's willingness to move to a new situation to which he attaches a different subjective distribution of quality when he is free to adjust his consumption bundle.[71] CV is defined as:

$$CV = e(p_0, \overline{U}_0, \theta_0) - e(p_0, \overline{U}_0, \theta_1) \quad (3)$$

where the subscript 0, 1 represents before and after the change, respectively. CV measures the welfare change under perfect information.

In the case of perfect information, an individual chooses to consume $x_0$ in the initial circumstance when the subjective distribution parameter is $\theta_0$ (prior beliefs) and then moves to $x_1$, when the subjective distribution of quality changes to $\theta_1$ (posterior beliefs).[72] The optimal $x_1$ may be greater or less than the optimal $x_0$ because the prior information could be less accurate in either direction. That is, the individual might

[69] This expenditure function can also be obtained by the following cost minimization problem.
[70] For more explanation about CV and the derivation of (3), see Appendix H.
[71] The different subjective distribution of quality is tantamount to a change in the shape of the indifference curve in Figure 7.
[72] According to Teisl et al. (2001), in the nutrition information case, we do not face a change in the quality per se, but we do face a difference in information.

initially believe that the quality is either higher or lower than the better assessment suggests. Nutrition information allows one to update their subjective distribution, captured by $\theta_1$, which is at least as accurate, and possibly more so.

The CV measure in (3) could be either positive or negative depending whether the information signal is an improvement or degradation.[73] The sign is negative when the change is degradation in quality ($\theta_1 < \theta_0$) because the expenditure has to increase to maintain the utility level, $e(p_0, \bar{U}_0, \theta_0) < e(p_0, \bar{U}_0, \theta_1)$. If $\theta_1$ were to reflect an improvement ($\theta_1 > \theta_0$), the expression in (3) would be equally correct but the sign would be positive. This measure of consumer loss (gain) is equal to the change in the area under the compensated demand curve at the initial utility level. The illustrations in detail are provided in Appendix I.

Expression (3) is correct only if the individual is apprised of the change in $\theta$. Foster and Just viewed the loss for the individual who is *not* told of the contamination as greater than expression (3), since the individual suffers the same potential risk as the informed individual but is unable to adjust his consumption to reflect his aversion to that risk. This welfare loss of the uninformed individual is given by the compensating surplus (CpS) measure.[74] Compensating surplus is defined as the amount of additional money required to keep the consumer as well off after the change as in the initial state if

[73] The signing convention is different between these two papers. This study follows the convention of Teisl et al. (2001).
[74] It was abbreviated as CS in the original literature. In this study, CS is used for the consumer surplus so CpS is used for compensating surplus.

he is not free to adjust consumption quantities of the goods of interest. CpS measures the welfare change under imperfect information.

$$CpS = e(p_0, \overline{U}_0, \theta_0) - e(p_0, \overline{U}_0, \theta_1 | x = x_0) \quad (4)$$

In (4), $x$ is constrained to be at the level that would be optimal when $\theta = \theta_0$. In other words, consumers are forced to consume the same quantities of the goods of interest that they would have chosen under ignorance. In the contamination case, expression (4) is negative and is larger in absolute value than (3). In improvement case, (4) is positive and smaller than (3).[75]

The difference between expression (3) and (4) becomes the difference of welfare change between under perfect information and under imperfect information, that is, the cost of ignorance (COI).

$$COI = CpS - CV = e(p_0, \overline{U}_0, \theta_1) - e(p_0, \overline{U}_0, \theta_1 | x = x_0) \quad (5)$$

This COI measures consumer welfare under conditions of updated information ($\theta_1$) by comparing $x_1$ in the informed case with $x_0$ of the uninformed case. COI < 0 implies a loss. This expression is not positive irrespective of whether $\theta_1$ represents an improved or degraded quality distribution relative to $\theta_0$.[76] The value of information is equal to the opposite sign of COI, which is non-negative.

However, it is difficult to measure COI empirically by equation (5) because the restricted expenditure function cannot be observed. Foster and Just then considered

[75] See Appendix I for the illustration.
[76] Again, see Appendix I for the illustration.

finding a price $p_1$ such that compensated demand at that price and with quality distribution parameters $\theta_1$ is equal to the initial level of consumption $x_0$. That is, Hicksian demand $h(p_1, \bar{U}_0, \theta_1) = x_0$ . Then compensating surplus (CpS) can be calculated as:

$$CpS = [e(p_0, \bar{U}_0, \theta_0) - p_0 x_0] - [e(p_1, \bar{U}_0, \theta_1) - p_1 x_0]$$

$$= e(p_0, \bar{U}_0, \theta_0) - e(p_1, \bar{U}_0, \theta_1) - (p_0 - p_1) x_0 \qquad (4')$$

From (4') and (5), (5) is equivalent to (5') which can be calculated.

$$COI = e(p_0, \bar{U}_0, \theta_1) - (p_0 - p_1) x_0 - e(p_1, \bar{U}_0, \theta_1) \qquad (5')$$

### 4.1.3 Consumer Surplus

Since this study deals with discrete choice models, the expenditure function is not applicable. Instead, the logit model has a convenient form to calculate the consumer surplus (CS). While compensating variation (CV) and equivalent variation (EV) are based on Hicksian demand, consumer surplus is based on Marshallian demand.[77] In a case where there is no income effect, CV, EV, and CS are equal. Though the measure of CV or EV is more attractive because it does not assume a constant marginal utility of income, in practice the CS is by far the most used measure, sometimes explicitly as an approximation of the CV, because researchers feel that information for CV or EV is

[77] A price change generally leads to both a substitution effect (from one good to the other) and an income effect (more or less purchasing power for all goods because of an expansion or contraction of the budget). The Marshallian demand curve gives the substitution effect only; the Hicksian or compensated demand curve gives substitution and income effects. In general, the consumer surplus is between the compensating variation and the equivalent variation.

lacking (de Jong et al., 2005). The following shows the calculation of the consumer surplus from logit model, based on the textbook written by Train (2003).[78]

By definition, the individual's consumer surplus is the utility that the person receives in the choice situation represented in monetary terms.[79] Since a consumer is assumed to choose the alternative that provides the greatest utility, consumer surplus is written as:

$$CS_i = \frac{1}{\alpha_i} max_j(U_{ij} \quad \forall j)$$

where $\alpha_i$ is the marginal utility of income: $\frac{dU_i}{dY_i} = \alpha_i$, with $Y_i$ the income of person $i$. The reciprocal $\frac{1}{\alpha_i}(= \frac{dY_i}{dU_i})$ translates utility into monetary term. Because consumer's utility $U_{ij}$ is not observable, the observable part of the utility $V_{ij}$ and the distribution of $\varepsilon_{ij}$ are used to calculate the expected consumer surplus:[80]

$$E(CS_i) = \frac{1}{\alpha_i} E\left[max_j(V_{ij} + \varepsilon_{ij} \quad \forall j)\right] \tag{6}$$

Williams (1977) and Small and Rosen (1981) showed that if each $\varepsilon_{ij}$ is independent and identically distributed (*iid*) with the extreme value and utility is linear in income (so that $\alpha_i$ is constant with respect to income), then (6) becomes

---

[78] Though it is not used in this study, a slightly different interpretation, namely the logsum as a measure of accessibility, is given in the textbook by Ben-Akiva and Lerman (1985).

[79] Consumer surplus associated with price movement from $p_0$ to $p_1$ is the area to the left of the demand curve between $p_0$ and $p_1$. When the consumer's preferences can be represented by a quasilinear utility function, consumer's surplus is an exact measure of welfare change (Varian, 2003).

[80] $U_{ij}=V_{ij}+\varepsilon_{ij}$. See subsection 3.4.1.

$$E(CS_i) = \frac{1}{\alpha_i} ln\left(\sum_{j=1}^{J} e^{V_{ij}}\right) + C \tag{7}$$

where C is an unknown constant.

The argument in parentheses in (7) is the same as the denominator of the logit choice probability, $\text{Prob}(Y_i = j) = \frac{e^{V_{ij}}}{\sum_{j=1}^{J} e^{V_{ij}}}$.[81] It is often called the *log-sum* (*logsum*) term. This resemblance between the two formulas has no economic meaning, but is simply the outcome of the mathematical form of the extreme value distribution. However, the relation makes calculation of expected consumer surplus easy, which is one of the many conveniences of logit (Train, 2003).

The change in consumer surplus that results from a change in the alternatives and/or the choice set is calculated from (7). $E(CS_i)$ is calculated twice: first under the conditions before the change, and again under the conditions after the change. The difference between the two results is the change in consumer surplus.

$$\Delta E(CS_i) = \frac{1}{\alpha_i}\left[ln\left(\sum_{j=1}^{J^1} e^{V_{ij}^1}\right) - ln\left(\sum_{j=1}^{J^0} e^{V_{ij}^0}\right)\right] \tag{8}$$

where the superscripts 0 and 1 refer to before and after the change. The number of alternatives can change as well as the attributes of the alternatives. Since the unknown constant C enters expected consumer surplus both before and after the change, it drops

[81] See subsection 3.4.2.

out of the difference and can therefore be ignored when calculating changes in consumer surplus.

The $\alpha_i$ is the marginal utility of income which needs to be estimated. Usually a price or cost variable enters the representative utility, in which case the negative of its coefficient is $\alpha_i$ by definition. A one-dollar reduction in costs is equivalent to a one-dollar increase in income, since the person gets to spend the dollar that he saves in purchase costs just the same as if he got the extra dollar in income.

The formula (8) for expected consumer surplus depends on the assumption that the marginal utility of income is independent from income. If the marginal utility of income changes with income, then a more complicated formula is needed, since $\alpha_i$ itself becomes a function of the change in attributes (Train 2003). In this study, $\alpha_i$ has been assumed to be constant over time and over the sample, independent from income for simplicity.

## 4.2 Literature Review

### 4.2.1 Logsum Approach

The so-called logsum-approach, rooted in random utility-based discrete-choice theory (McFadden, 1973; Ben-Akiva and Lerman, 1985), has served for over two decades as the dominant means to assess the benefits, conceptualized as differences in expected consumer surplus.[82] It is widely recognized that the popularity of the logsum as an evaluation measure results from its elegant combination of formal tractability and a strong foundation in microeconomic theories of discrete choice (Chorus and Timmermans, 2009). Though some recent studies try to incorporate the income effect or variation in tastes, practical appraisal procedures have almost exclusively been based on the simpler, earlier, models (de Jong, 2005).

Welfare analysis measured by consumer surplus is studied mostly in the context of transportation mode choice. Castiglione et al. (2003) evaluated the proposed New Central Subway project in downtown San Francisco. Odeck et al. (2003) investigated the magnitude of socio-economic benefits that may be gained by converting the current cordon based road pricing scheme in Oslo to a road congestion pricing scheme. Gupta et al. (2004) looked at the impacts of new toll roads, as well as possible bridge and downtown cordon toll policies in Austin, Texas. Chorus and Timmermans (2009) derived and illustrated measures for the ex-ante evaluation of user benefits associated with improvements in transport systems.

In logsum approach, the time or cost coefficients of the estimation are used to convert utilities to money or time. Castiglione et al. (2003) did not convert the logsum change in utilities directly into money units, but convert it to time in minutes. However, most applications used cost coefficients to convert outcomes to money units. The

[82] See section 3.4 for the theoretical framework of random utility theory and discrete choice theory.

applications of the logsum concept in transport project appraisal generally used a relatively simple formulation that assumes constant marginal utility of money.

### 4.2.2 Value of Information

Foster and Just (1989) applied their consumer welfare calculation methodology to a milk contamination case in Hawaii which reduced milk consumption by over 80%. Their estimation yielded the welfare loss (CV) of $8.33 per person per month in Februrary 1982, which was the month previous to the month when the public first became aware of the contamination problem.[83] They also calculated CpS of $18.21 per person per month, thus the COI was $9.88 per person per month for each month that public officials withheld information.

Teisl and Roe (1998) found COI to be a suitable measure to assess the benefit of a labeling policy. An empirical application by Teisl et al. (2001) assessed the welfare impact of nutritional information in the context of an experimental labeling program. Their value of information (VOI) approach yielded present values of the social benefit of nutrition shelf labeling equal to $6.3 billion (milk), $4.8 billion (peanut butter), $2.3 billion (salad dressing), and $1.4 billion (mayonnaise). They suggested that the total social benefit measured using the VOI approach is likely to far exceed the FDA's benefit

[83] The CV is the estimated value for the situation of consumers could have responded to true information.

estimate for the Nutrition Labeling and Education Act of 1990 (NLEA) that was based on the cost-of-illness approach.

Mazzocchi et. al. (2004) developed a measure of consumer welfare losses associated with withholding information about a possible link between BSE and variant Creutzfeldt-Jakob disease (vCJD). COI was measured by comparing the utility of informed choice with the utility of uninformed choice, under conditions of improved information. The measure was obtained by retrieving a cost function from a dynamic Almost Ideal Demand System (AIDS). The estimated perceived loss for Italian consumers due to delayed information ranged from 12 percent to 54 percent of total meat expenditure, depending on the month assumed to embody correct beliefs about the safety level of beef.

## 4.3 Data

Even though purchases of omega-3 eggs have increased from 1998 to 2007, consumers who have ever bought omega-3 eggs still remain as a small percentage of all consumers. Thus, the subsample of households is selected to clearly see the welfare change caused by purchasing omega-3 eggs. The selected households are those that participated in the survey in both 1998 and in 2007 and also bought omega-3 eggs in either year.

This analysis is based on the binary choice of whether they buy omega-3 eggs or regular eggs, conditional on buying some eggs. The numbers of households that participated in the survey in both 1998 and in 2007 and bought eggs of any type in either year are 2,130. Among them, 139 households bought omega-3 eggs in 1998, 324 households bought them in 2007, and 60 households bought them in both years. Thus, 403 households who bought omega-3 eggs either in 1998 or in 2007 are selected for analyzing the change in consumer welfare.

The descriptive statistics of the subsample are summarized in Table 21 on the next page. The number of households selected is 403 for both years. It accounts for 5.5% of the sample in 1998 and 0.7% of the sample in 2007.[84] They are the same households in 1998 and in 2007; thus, it is not surprising that some of their demographic statistics change in accordance with lifecycle progression.[85] Compared to the whole sample, the selected households have higher average income, and more household heads have a college degree. These are consistent with the profile of omega-3 products buyers as indicated in the literature, such as Mintel (2008) or Chase et al. (2007). Compared to the whole sample, this subsample is more likely to be located in the eastern region and less likely to be in the central region. In addition, they are more likely to live in an urban area (major market).

[84] Total numbers of households in total sample in 1998 and in 2007 are 7,304 and 59,384, respectively. See section 3.2 for detail.
[85] For example, the average age of household head increased from 52 to 60.

**Table 21 Demographic Variables for Selected Subsample and Whole Sample**

| Demographic Variable | 1998 | 2007 | 98-'07 Average of Whole Sample |
|---|---|---|---|
| Number of Households | 403 | 403 | 21503 |
| | | | |
| **Household Size** | | | |
| Mean | 2.48 | 2.12 | 2.45 |
| Standard Deviation | 1.22 | 1.04 | 1.32 |
| Minimum | 1 | 1 | 1 |
| Maximum | 7 | 9 | 9 |
| | | | |
| **Household Income** | | | |
| Mean ($1,000) | 58.67 | 61.64 | 55.15 |
| Standard Deviation | 35.62 | 36.31 | 36.51 |
| Minimum | Under $5000 | Under $5000 | Under $5000 |
| Maximum | $100,000+ | $100,000+ | $100,000+ |
| | | | |
| **Age of Head** | | | |
| Mean | 52.4 | 60.02 | 52.61 |
| Standard Deviation | 11.17 | 9.59 | 12.59 |
| Minimum | <25 Years | 25-29 Years | <25 Years |
| Maximum | 65+ Years | 65+ Years | 65+ Years |
| | | | |
| **Education of Head** | | | |
| Without College Degree | 230 (57.1) | 224 (55.6) | 13330 (62.0) |
| With College Degree | 173 (42.9) | 179 (44.4) | 8173 (38.0) |
| | | | |
| **Region** | | | |
| East | 108 (26.8) | 100 (24.8) | 3700.8 (17.2) |
| Central | 69 (17.1) | 66 (16.4) | 5218.3 (24.3) |
| South | 150 (37.2) | 162 (40.2) | 8096.5 (37.7) |
| West | 76 (18.9) | 75 (18.6) | 4487.4 (20.9) |
| | | | |
| **Major Market** | | | |
| Yes | 259 (64.3) | 275 (68.2) | 8702.9 (40.5) |
| No | 144 (35.7) | 128 (31.8) | 12800.1 (59.5) |

Percentage in parentheses.

The egg purchasing behaviors of these households are summarized in Table 22. They became more likely to buy omega-3 eggs over this period. Prices increased for both regular eggs and omega-3 eggs from 1998 to 2007. The relative price is the price of omega-3 eggs divided by the price of regular eggs.

**Table 22 Egg Purchasing Behavior of the Selected Subsample**

| | 1998 | | | | 2007 | | | |
|---|---|---|---|---|---|---|---|---|
| Number of Households | 403 | | | | 403 | | | |
| Number of Households That Bought Omega-3 Eggs in Any Month in the Year | 139 (34.5%) | | | | 324 (80.4%) | | | |
| | Mean | S.D. | Min | Max | Mean | S.D. | Min | Max |
| Number of the Months the HH Bought Any Eggs | 8.15 | 3.06 | 1 | 12 | 7.72 | 3.16 | 1 | 12 |
| Number of the Months the HH Bought Only Regular Eggs | 7.43 | 3.31 | 0 | 12 | 5.13 | 3.49 | 0 | 12 |
| Number of the Months the HH Bought Omega-3 Eggs | 0.72 | 1.54 | 0 | 12 | 2.58 | 2.94 | 0 | 12 |
| Regular Egg Price ($, dozen) | 1.11 | 0.49 | 0 | 4.98 | 1.65 | 0.67 | 0 | 7.49 |
| Omega-3 Egg Price ($, dozen) | 1.81 | 0.18 | 0 | 3.59 | 2.39 | 0.43 | 0 | 5.98 |
| Relative Egg Price | 2.07 | 6.53 | 0 | 342.71 | 1.64 | 1.15 | 0 | 34.25 |

## 4.4 Methods

The welfare change and the value of information are both estimated in this study. There is no substantial shock which is expected to cause an immediate large change. Rather, the change is assumed to be gradual. This study compares the consumers' welfare in 1998 and in 2007 assuming that consumers' knowledge on nutritional benefits of omega-3 eggs increased during the period.

Expected consumer surplus is calculated by the formula: [86]

$$\Delta E(CS_i) = \frac{1}{\alpha}\left[ln\left(\sum_{j=1}^{2} e^{V_{ij}^{1}}\right) - ln\left(\sum_{j=1}^{2} e^{V_{ij}^{0}}\right)\right] \qquad (9)$$

where $i$ represents the household, $\alpha$ is the marginal utility of income, the superscripts 0 refers to the year 1998 and 1 refers to the year 2007, and $j$ is the alternative ($j$=1 is regular eggs and $j$=2 is omega-3 eggs). $V_{ij}^{t}$ ($t$ is the year indicating either 1998 or 2007) is specified to be linear in parameters: $V_{ij}^{t} = \mathbf{x}_{ij}^{t\prime}\boldsymbol{\beta}_{j}^{t}$. Because the probabilities sum to one, we can normalize it by setting $\boldsymbol{\beta}_{1}^{t} = \mathbf{0}$. Let the normalized $\boldsymbol{\beta}_{2}^{t} = \boldsymbol{\beta}^{t}$**.** Then, (9) becomes:

$$\Delta E(CS_i) = \frac{1}{\alpha}\left[ln\left(1 + e^{\mathbf{x}_i^{\mathbf{1}\prime}\boldsymbol{\beta}^{\mathbf{1}}}\right) - ln\left(1 + e^{\mathbf{x}_i^{\mathbf{0}\prime}\boldsymbol{\beta}^{\mathbf{0}}}\right)\right]$$

In this study, the price of the regular eggs is normalized as 1. So, the price used in the regression is the relative price (price of omega-3 eggs/price of regular eggs). The logistic regressions using the variables listed in Table 23 are conducted for the

[86] See subsection 4.1.2 for detail.

subsample for each year. The coefficients obtained from these regressions ($\boldsymbol{\beta}^t$) are used to calculate $ln\left(1 + e^{\mathbf{x}_i^1 \boldsymbol{\beta}^t}\right)$ for each year *t*. These are based on monthly household data, so the annual average of the log-sum term for each household is taken as the log-sum term for the household for each year *t*.

**Table 23 Explanatory Variables Used in Logistic Regression for Welfare Analysis**

| | |
|---|---|
| Household Size | West (D) |
| Household Income ($1,000) | Spring (D) |
| Age of Household Head | Fall (D) |
| Education of Household Head (D) | Winter (D) |
| Major Market (D) | Relative Egg Price (dozen, $) |
| East (D) | Regular Egg Deal (D) |
| Central (D) | Current Media Index for Health |

(D) indicates dummy variable.

The marginal utility of income $\alpha$ is calculated by the coefficient on the price variable, assuming that it is constant and the same for both years. Since the price here is not an absolute value of the price but a relative price, the coefficient is the marginal utility of relative price. For policy analysis absolute levels are not required, rather only changes in consumer surplus are relevant (Train, 2003). To obtain $\alpha$, two years' subsamples are appended and the logistic regression with the same variables as above is conducted for the whole subsample. The coefficient of the relative price is taken as $\alpha$ for all households.

The change of consumer surplus (CS), which is an approximation of the compensating variation (CV), over these years is calculated as follows.[87] To avoid further confusion, here the subscript b, a, c denotes before the change, after the change, and under the constraint that the same amount of consumption is forced, respectively. From (3),

$$CV = V(p_a, y_a, \theta_a) - V(p_b, y_b, \theta_b)$$

Then, the welfare measure equivalent to the compensating surplus is calculated as follows. From (4'),

$$CpS = V(p_c, y_c, \theta_a) - V(p_b, y_b, \theta_b) - (p_b - p_c)x_b \qquad (10)$$

The price ($p_{ic}$) which yields the same utility level as before is estimated by solving $\mathbf{x}_i^{b\prime}\boldsymbol{\beta}^b = \mathbf{x}_i^{a\prime}\boldsymbol{\beta}^a$ with the relative price value in $\mathbf{x}_i^a$( $\mathrm{x}_{i,relprice}^a$) to be obtained, where the superscript b (before) means the year 1998 and a (after) means the year 2007. $\mathbf{x}_i^{b\prime}\boldsymbol{\beta}^b$ is the annual average of the estimated utility for each household in 1998. Solving this, estimated price for household *i* is obtained as:

$$p_{ic} = (\mathbf{x}_i^{b\prime}\boldsymbol{\beta}^b - \mathbf{x}_i^{a\prime}\boldsymbol{\beta}^a + \mathrm{x}_{i,rel_{price}}^a \beta_{rel_{price}}^a)/\beta_{rel_{price}}^a$$

The estimated price and the same level of consumption as in 1998, which are considered as the annual average of relative probability (probability of purchasing omega-3 eggs/probability of purchasing regular eggs) in 1998 for each household, is used to calculate the first two terms in the equation (10). The same $\alpha$ as above is used. The third term is calculated using the estimated price and the original price, and the

[87] Assuming that there is no income effect, CS serves as the CV. See subsection 4.1.3.

annual average of relative omega-3 eggs purchasing probability in 1998 for each household.

After obtaining the CV and the CpS, the value of information (VOI) is also calculated by taking their difference. All of these calculations are conducted at the household level and then the average of the whole sample is taken as the welfare change.

## 4.5 Results

The results from the welfare analysis are summarized in Table 24.

**Table 24 Results from Welfare Analysis**

| | | | | |
|---|---|---|---|---|
| Consumer Surplus (CS) | 1.0839 | | | |
| Compensating Surplus (CpS) | 0.2916 | | | |
| Cost of Ignorance (COI) | -0.7923 | | | |
| Value of Information (VOI) | 0.7923 | | | |
| | Mean | S.D. | Min | Max |
| Estimated Relative Price | 5.64 | 1.19 | 1.3 | 8.86 |

The measure of the compensating variation is equivalent to the measure of the consumer surplus, assuming there is no income effect. Instead of the marginal utility of income, the marginal utility of relative price is calculated as the coefficient of the relative price. The marginal utility of relative price is 0.31.

The measure of the compensating surplus is calculated by estimating the price and also using the measure of the consumer surplus. The marginal utility of relative price, 0.31, is used in this calculation as well. The average of the estimated relative price is 5.64. To maintain the same utility in 2007 as in 1998, the price of omega-3 eggs should be 5.64 times as high as that of regular eggs. In equation (10), the first two terms are -0.01 and the third term is 0.31, so the compensating surplus equivalent is 0.29.

Since the cost of ignorance is the difference between the compensating surplus and compensating variation, it is 0.29 - 1.08 = -0.79. The opposite sign of the cost of ignorance is equal to the value of information, which is 0.79.

## 4.6 Key Findings

The change of the consumer surplus is positive, which implies that the consumers are better off in 2007 compared to in 1998. Both the compensating variation and the compensating surplus calculated for this subsample are positive, and the compensating variation is greater than the compensating surplus. The value of information, which is based on this difference, is positive. These results are all consistent with the theoretical framework.

# 5. Conclusions

This study estimates the impact of nutrition information – health and developmental benefits of omega-3 fatty acids – provided by popular media has had on U.S. consumers' purchases of omega-3 eggs. These consumers' probability of purchase of omega-3 eggs between 1998 and 2007, as measured in the AC Nielsen Homescan® data, is analyzed using logistic regression, probit regression, and multinomial logistic regression methods. Also, the welfare change is analyzed by using the consumer surplus and the value of information scheme.

## 5.1 Summary

The Media Index for information about omega-3 health benefits, especially of the current month, has a significantly positive impact on purchases of omega-3 eggs. The results are quite similar among the three popular empirical models; logit, probit, and multinomial logit. This result implies that consumers obtain new scientific nutritional knowledge through the popular media and consumers' purchase choices reflect their knowledge of new nutritional information and its connection with food. The targeted message on developmental benefits works the same as the message on health benefits, that is the targeted message and general message are received by consumers in a same way. It implies a difficulty to reach the intended consumers with targeted messages.

Other variables also have significant impacts on omega-3 eggs purchase choice. Increased higher household income, age of heads, and education of heads have positive relationships with the probability of purchasing omega-3 eggs. On the other hand, larger household size has a negative relationship. If households are living in an urban area, the probability of buying omega-3 eggs increases. Consumers are quite sensitive to the prices of regular eggs, but are not very sensitive to a change in the price of omega-3 eggs.

Regarding the welfare analysis, the welfare of consumers who purchases omega-3 eggs, measured by their consumer surplus, increased from 1998 to 2007. Although it is not a direct measure of the information, consumer's knowledge on the nutritional benefits of the omega-3 eggs in 1998 and that in 2007 are assumed to be different. When the welfare change is investigated further using the concept of the value of information, most of the welfare change is accounted for by the information.

## 5.2 Discussions

Although Omega-3 eggs usually sell at a premium price compared to the typical eggs, growing knowledge of the health benefits of omega-3 propels their consumption.

Price is surely important, but new nutritional information can also affect consumers' food choices by reducing uncertainty about the health attributes of those foods. Since people are more aware of their health problems, they further appreciate these kinds of food characteristics. The functional food market is getting bigger to better match consumers' interests, with support from authorities, such as the health claim regulations announced by FDA.

The impact from the popular media is substantial. Various new nutritional information sources are available to consumers. Among them, the information provided by popular media is more accessible than doctors' recommendations and also more organized and credible than the information found by searching the Internet. To change dietary behaviors in order to promote health, publishing in the popular media can be said to be an effective communication approach.

In fact, the welfare of the consumers who are aware of omega-3 eggs increased over time. It is assumed that they get more knowledge on omega-3 eggs health benefits and adjust their egg purchase behavior according to that. If they are not allowed to adjust their consumption, the benefit becomes smaller. It seems to be fair to conclude that the information has value on consumers.

## 5.3 Suggestions for Future Research

As with any research, this study has limitations. The following are some suggestions for future research.

Regarding the product of interest, omega-3 fortified egg is just one example from a long list of omega-3 fortified products. Consumers' choice of functional foods, along with foods such as fatty fish or omega-3 dietary supplements, may have been impacted differently. For example, cereal, milk, and yogurt enhanced with omega-3 are popular functional foods (Mintel 2008).

The information communication method in this study is one-way. A sender who wants to send a message sends the messages to the consumers (subscribers) in order for the message to be received. However, the interaction between the sender and the user via the Internet and social media has become too large to ignore. It is worth researching the impact of these interactions, though the reliable data are hard to obtain compared to the ones used in this study such as newspaper articles.

Most of choice studies do not progress beyond using the multinomial logit model (Hensher et al., 2005), but other model specifications may be more realistic. For example, a nested logit model relaxes the assumption of independent and identically distributed (*iid*) error terms, which has an equivalent behavioral assumption, the assumption of independence from irrelevant alternatives (*IIA*) by grouping similar alternatives together by allowing their error terms to be correlated. The Berry, Levinsohn and Pakes (BLP, 1995) model allows for unobserved product characteristics and consumer heterogeneity in tastes for characteristics.

There are also several appealing questions which are beyond the scope of this study or which cannot be answered by the dataset used in this study. For example, it would be interesting to see how long new information needs to be in the media before it starts to affect people's purchases. Another example is that it would be useful to track consumer's behavior to see their loyalty to the product of interest, i.e., whether to continue to buy omega-3 eggs after they first make a decision to buy those eggs.

## 5.4 Concluding Remarks

New nutritional information provided by popular media substantially affects consumers' food choices by reducing uncertainty about the health attributes of those foods. Even though functional foods are sold at a higher price, consumers choose them for their health benefits and consequently their utility increases. Since consumers have become increasingly concerned with their health, popular media can be an effective communication approach for changing dietary behaviors.

## References


Allen, K. and M. Harris, 2001. "The role of n-3 fatty acids in gestation and parturition." *Experimental Biology and Medicine*, 226, 498.

Amemiya, T., 1981. "Qualitative Response Models: A Survey." *Journal of Economic literature*, 19,4, 481-536.

Bang, H., J. Dyerberg, and H. Sinclair, 1980. "The Composition of the Eskimo Food in North Western Greenland." *American Journal of Clinical Nutrition*, 33(12), 2657-2661.

Ben-Akiva, M. and S. R. Lerman, 1985. *Discrete choice analysis: Theory and application to travel demand*, MIT Press, Cambridge, Massachusetts.

Berry. S, J. Levinsohn, and A. Pakes, 1995. "Automobile Prices in Market Equilibrium." *Econometrica*, 63(4), July, 841-890.

Broughton, K.S., C.S. Johnson, B.K. Pace, M. Liebman, and K.M. Kleppinger, 1997. "Reduced asthma symptoms with n-3 fatty acids ingestion are related to 5-series leukotriene production." *American Journal of Clinical Nutrition*, 65(4), 1011-1017.

Brown, D. J., and L. F. Schrader, 1990. "Cholesterol Information and Shell Egg Consumption." *American Journal of Agricultural Economics, 72*(3), 548-555.

Burton, M., and T. Young, 1996. "The Impact of BSE on the Demand for Beef and Other Meats in Great Britain." *Applied Economics, 28*(6), 687-693.

Capps, O. Jr., and J. Park, 2002. "Impacts of Advertising, Attitudes, Lifestyles, and Health on the Demand for U.S. pork: A Micro-level Analysis." *Journal of Agricultural and Applied Economics, 34*(1), 1-15.

Castiglione, J., J. Freedman, and W. Davidson, 2003. "Application of a tour-based microsimulation model to a major transit investment." *San Francisco County Transportation Authority and PB Consult*, San Francisco.

Chang, H., and H. Kinnucan, 1991. “Advertising, Information, and Product Quality: The Case of Butter.” *American Journal of Agricultural Economics*, 73, 1195-1203.

Chang, H., and D. R. Just, 2007. “Health Information Availability and the Consumption of Eggs: Are Consumers Bayesians?” *Journal of Agricultural and Resource Economics, 32*(1), 77-92.

Chase, D., T. Nilsson, J. P. Emunu, D. McCann-Hiltz, and Y. Peng, 2007. “Canadian Consumer Attitudes and Purchasing Behaviour of Omega-3 Products.” *Project Report*, Dept. Rural Economy, University of Alberta, September.

Cherchi, E., J. Polak, and G. Hyman, 2004. “The impact of income, tastes and substitution effects on the assessment of user benefits using discrete choice models.” *European Transport Conference*, Strasbourg.

Chidmi, B. and R. Lopez, 2007. "The Role of Retail Services in Food Market Equilibrium," *International European Forum on Innovation and System Dynamics in Food Networks 2007 1st Forum*, February, Innsbruck, Austria.

Chorus, C. G. & H. J. P. Timmermans, 2009. "Measuring user benefits of changes in the transport system when traveler awareness is limited." *Transportation Research Part A: Policy and Practice*, 43(5), 536-547, June.

Clarke, D. G., 1976. “Econometric Measurement of the Duration of Advertising Effect on Sales.” *Journal of Marketing Research, 13*(4), 345-357.

Cragg, J. G., 1971. “Some statistical models for limited dependent variables with application to the demand for durable goods.” *Econometrica*, 39 (5), September 1971: 829-44.

Deaton, A. & J. Muellbauer, 1980. *Economics and Consumer Behavior*, Cambridge Books, Cambridge University Press.

de Jong, G., M. Pieters, A. Daly, I. Graafland-Essers, E. Kroes and C. Koopmans, 2005. “Using the Logsum as an Evaluation Measure: Literature and Case Study.” *Working paper WR-275-AVV*, RAND Corporation.

Dietary Guidelines Advisory Committee, 2005. *Dietary Guidelines for Americans*, HHS and USDA.

Einav, L., E. Leibtag, and A. Nevo, 2008. "On the Accuracy of Nielsen Homescan Data." *ERR-69*, USDA, ERS, December.

Fan, D. P. and R. D. Cook, 2003. "A differential equation model for predicting public opinions and behaviors from persuasive information: Application to the index of consumer sentiment." *The Journal of Mathematical Sociology*, 27(1): 29 - 51.

Fan, D. P., and Holway, W. B., 1994. "Media coverage of cocaine and its impact on usage patterns.", *International Journal of Public Opinion Research*, 6(2), 139-162.

Feick, L. F., R. O. Hermann, and R. H. Warland, 1986. "Search for Nutrition Information: A Probit Analysis of the Use of Different Information Sources." *Journal of Consumer Affairs*, *20*(2), 173-192.

Food Marketing Institute, 2008. *U.S. Grocery Shopper Trends*.

Foster, W., and Just, R. E,. 1989. "Measuring welfare effects of product contamination with consumer uncertainty." *Journal of Environmental Economics and Management*, 17(3), 266-283.

Friedberg, C.E., M. J. Janssen, R. J. Heine, and D.E. Grobbee, 1998. "Fish oil and glycemic control in diabetes." *Diabetes Care*, 21(4), 494-500.

Fuller, F. H., J. C. Beghin, and S. Rozelle, 2004. "Urban demand for dairy products in china: Evidence from survey data.", *Working Paper 04-WP 380,* November, Center for Agricultural and Rural Development, Iowa State University.

Ghebremeskel, K., Y. Min, M. A. Crawford, J. H. Nam, A. Kim, J. N. Koo, and H. Suzuki, 2000. "Blood fatty acid composition of pregnant and nonpregnant Korean women: Red cells may act as a reservoir of arachidonic acid and docosahexaenoic acid for utilization by the developing fetus." *Lipids*, 35(5), 567-574.

Goddard, E., P. Boxall, J. P. Emunu, C. Boyd, A. Asselin, and A. Neall, 2007. "*Consumer Attitudes, Willingness to Pay and Revealed Preferences for Different Egg Production Attributes: Analysis of Canadian Egg Consumers." Project Report,* Dept. Rural Economy, University of Alberta, July.

Greene, W.M., 2003. *Econometric Analysis*, fifth edition, Pearson Education.

Gupta, S., S. Kalmanje, and K. M. Kockelman, 2004. "Road Pricing Simulations: Traffic, Land Use and Welfare Impacts for Austin, Texas." *84th Annual Meeting of the Transportation Board and for Publication Transportation Research Record*.

Harris, W. S., and C. von Schacky, 2004. "The omega-3 index: A new risk factor for death from coronary heart disease?" *Preventive Medicine* 39 (1) (July): 212-20.

Hensher, D. A., J. M. Rose, and W. H. Greene, 2005. *Applied Choice Analysis: A Primer*, Cambridge University Press.

Horrobin, D.F, 1987. "Low prevalences of coronary heart disease (CHD), psoriasis, asthma and rheumatoid arthritis in Eskimos: Are they caused by high dietary intake of eicosapentaenoic acid (EPA), a genetic variation of essential fatty acid (EFA) metabolism or a combination of both?" *Med Hypotheses*, 22(4), 421-428.

IFIC, 2005. *Functional Foods Fact Sheet: Omega-3 Fatty Acids*. February 2005.

Ippolito, P. M., and J. K. Pappalardo, 2002. "*Advertising Nutrition and Health: Evidence from Food Advertising 1977-1997*." *Bureau of Economics Staff Report.* Federal Trade Commission, Washington DC, September.

Jensen, H. H., T. Kesavan, and S. R. Johnson, 1992. "Measuring the impact of health awareness on food demand." *Review of Agricultural Economics*, 14(2), 299-312.

Kim, S. R. and W. S. Chern, 1999. "Alternative measures of health information and demand for fats and oils in japan." *Journal of Consumer Affairs*, 33 (1): 92-109.

Kinsey, J., T. Roe, and B. Senauer, 1980. "Imperfect Information, Consumer Theory, and Allocative Error in Consumption." *Staff Paper* 13742, University of Minnesota, Department of Applied Economics.

Kinsey, J. R., W. Harrison, D. Degeneffe, G. Ferreira, and S. Shiratori, 2009. "Index of Consumer Confidence in the Safety of the United States Food System." *American Journal of Agricultural Economics* 91 (5): 1470-1476.

Kotilainen, L., R. Rajalahti, C. Ragasa, and E. Pehu, 2006. "Health enhancing foods, opportunities for strengthening the sector in developing countries." *Agriculture and rural development*, *Discussion paper 30*, Washington, D.C., World Bank.

Kris-Etherton, P. M., W. S. Harris, L. J. Appel and the Nutrition Committee, 2002. "Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease." *Circulation: Journal of American Heart Association*, 2747-2757.

Lewis, N.M., S. Seburg, N. L. Flanagan, 2000. "Enriched eggs as a source of N-3 polyunsaturated fatty acids for humans." *Poultry Science,* 79: 971-974.

LexisNexis® website, http://www.lexisnexis.com/about-us/, retrieved on 7/12/2011.

Liu, S., J. Huang, and G. L. Brown, 1998. "Information and Risk Perception: A Dynamic Adjustment Process." *Risk Analysis: An International Journal*, 18(6), 689-699.

Lopez, R. A. and X. Matschke, 2007. "Home Bias in U.S. Beer Consumption." *European Association of Agricultural Economists 105th Seminar*, March, Bologna, Italy.

Marschak, J., 1960. "Binary Choice Constraints on Random Utility Indicators." In Arrow, K., ed., *Stanford Symposium on Mathematical Methods in the Social Sciences*, Stanford University Press, Stanford, CA, 312-329.

Mazzocchi, M., 2006. "No news is good news: Stochastic parameters versus media coverage indices in demand models after food scares." *American Journal of Agricultural Economics*, 88(3), 727-741.

Mazzocchi, M., G. Stefani, and S. J. Henson, 2004. "Consumer welfare and the loss induced by withholding information: The case of BSE in Italy." *Journal of Agricultural Economics*, 55(1), 41-58.

McFadden, D., 1973. “Conditional Logit Analysis of Qualitative Choice Behavior.” In P. Zarembka, ed., *Frontiers in Econometrics*. New York: Academic Press.

McFadden, D., 1978. “Modelling the choice of residential location.” In Karlqvist, A., L. Lundqvist, F. Snickars, and J. Weibull, ed., *Spatial Interaction Theory and Residential Location*. North-Holland, Amsterdam.

McFadden, D., 1981. “Econometric models of probabilistic choice.” In Manski, C. and D. McFadden, ed., *Structural Analysis of Discrete Data: With Econometric Applications*. The MIT Press, Cambridge, Massachusetts.

Mintel, 2008. “*Mintel report: USA omega-3 January 2008”*, Retrieved from Mintel Oxygen Academic.

Nayga, R. M. Jr., D. Lipinski, and N. Savur, 1998. “Consumers' use of nutritional labels while food shopping and at home.” *Journal of Consumer Affairs,* 32 (1) (Summer 1998): 106-20.

Nettleton, J. A., 1993. “Are n-3 fatty acids essential nutrients for fetal and infant development?” *Journal of American Dietetic Association,* 93(1), 58-64.

Nutrition Business Journal, 2007. Retrieved on 2/26/2007 from the website: http://www.nutritionbusiness.com/.

Odeck, J., J. Rekdal, and T. N. Hamre, 2003. “The Socio-economic benefits of moving from cordon toll to congestion pricing: The case of Oslo.” *Transportation Research Board Annual meeting*.

Packaged Facts: A division of MarketResearch.com, 2007. *Functional, fortified and inherently healthy foods and beverages: The U.S. phood market.*

Paravolidaki, C., 2008. “Labelling, information asymmetry and functional foods: A case study of omega-3 enriched eggs.” *Master's thesis*, University of Saskatchewan.

Parsons, G. R., A. Morgan, J. C. Whitehead, and T. C. Haab, 2006. "The Welfare Effects of Pfiesteria-Related Fish Kills: A Contingent Behavior Analysis of Seafood Consumers," *Agricultural and Resource Economics Review*, 35(2), October.

Phiesteria and the Environment, 2011. Retrived on 7/9/2011 from the website: http://www.pfiesteria.org/.

Piggott, N. E., and T. L. Marsh, 2004. “Does Food Safety Information Impact U.S. Meat Demand?” *American Journal of Agricultural Economics, 86*(1), 154-174.

Rich, M. K., and A. Dahlhoff, 2003. “Assessment of Market Opportunities for Omega 3 eggs.” S*outhwest Marketing Advisory Center Research Project Report*, January 9, 2003.

Schlanger, S., M. Shinitzky, and D. Yam. 2002. “Diet enriched with omega-3 fatty acids alleviates convulsion symptoms in epilepsy patients.” *Epilepsia*, 43, 103.

Seaton, T, 2006. “*The omega-3 explosion*”, March 1, 2006. Retrieved on 12/20/2010 from the website: http://nutraceuticalsworld.com/contents/view/13525.

Seddon, J., B. Rosner, R. Sperduto, L. Yannuzzi, J. Haller, N. Blair, and W. Willett, 2001. “Dietary fat and risk for advanced age-related macular degeneration.” *Archives of Ophthalmology*, 119(8), 1191-1199.

Small, K. A. & H. S. Rosen, 1981. "Applied Welfare Economics with Discrete Choice Models." *Econometrica*, vol. 49(1), 105-30.

Smith, M. E., E. O.van Ravenswaay, and S. R. Thompson, 1988. “Sales loss determination in food contamination incidents: An application to milk bans in Hawaii.” *American Journal of Agricultural Economics*, 70(3), 513-520.

Sribney, W., 2005. “*Likelihood-ratio test after survey/robust ML estimation*”, Retrieved on 6/1/2011 from website http://www.stata.com/support/faqs/stat/lrtest.html.

Taylor, M. R., and D. Phaneuf, 2009. “Bayesian estimation of the impacts of food safety information on household demand for meat and poultry.” *Agricultural and Applied Economics Association 2009 Annual Meeting.*

Teisl, M. F., Bockstael, N. E., and Levy, A., 2001. "Measuring the welfare effects of nutrition information." *American Journal of Agricultural Economics*, 83(1), 133-149.

Teisl, M.F. and B. Roe, 1998. "The Economics of Labeling: An Overview of Issues for Health and Environmental Disclosure." *Agricultural and Resource Economics Review*, October 28, 140-150.

Terry, P., A. Wolk, H. Vainio, and E. Weiderpass, 2002. "Fatty fish consumption lowers the risk of endometrial cancer: A nationwide case-control study in Sweden." *Cancer Epidemiology Biomarkers Prevention*, 11, 143.

Terry, P., P. Lichtenstein, M. Feychting, A. Ahlborn, and A. Wolk, 2001. "Fatty fish consumption and risk of prostate cancer." *Lancet*, 357, 1764.

Thompson, S. R., and D. A. Eiler, 1975. "Producer returns from increased milk advertising." *American Journal of Agricultural Economics*, 57(3), 505-508.

Thurstone, L., 1927. "A Law of Comparative Judgement." *Psychological Review,* 34, 273-286.

Tobin, J., 1958. "Estimation of Relationships for Limited Dependent Variables." *Econometrica*, Vol. 26, No. 1, Jan, 24-36.

Train, K. E., 2003. *Discrete Choice Methods with Simulation.* Cambridge University Press.

van Elswyk, M. E., S. D. Hatch, G. G. Stella, P. K. Mayo, and K. S. Kubena, 1998. "Poultry-based alternatives for enhancing the ω3 fatty acid content of American diets." Pages 24–37 in: *The Return of ω-3 Fatty Acids into the Food Supply*. A. P. Simopoulos, ed. Karger, New York, NY.

Varian, H. R., 1992. *Microeconomic Analysis*, third edition, W.W. Norton & Company, New York, NY.

Verbeke, W., and R. W. Ward, 2001. “A Fresh Meat Almost Ideal Demand System Incorporating Negative TV Press and Advertising Impact.” *Agricultural Economics, 25*(2-3), 359-374.

von Schacky, C., and P. Angerer, W. Kothny, K. Thiesen, H. Mudra, 1999. The effect of dietary ω-3 fatty acids on coronary atherosclerosis. *Annals of Internal Medicine*, 130 (7) (04/06), 554.

Webb, T. J., D. N. Bengston, and D. P. Fan, 2008. "Forest value orientations in Australia: an application of computer content analysis." *Environmental Management*, 41: 52-63.

Whitney, E. N., and S. R. Rolfes, 2010. *Understanding nutrition*. 12th ed. Belmont: Wadsworth Publishing.

Williams, H. C. W. L., 1977. "On the formation of travel demand models and economic evaluation measures of user benefit." *Environment and Planning* A 9(3) 285 – 344.

Zou, N. N. and J. E. Hobbs, 2006. “Modelling Functional Food Choice and Health Care Impacts: A Literature Review.” *Project Report*, Nov, Dept. of Rural Economy, Faculty of Agriculture & Forestry, and Home Economics, University of Alberta.

# Appendix

## Appendix A. Household Panel Demographic Variables

| | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Demographic Variable | Freq | (%) | Freq | (%) | Freq | (%) | Freq | (%) | Freq | (%) |
| **Number of Households** | 7304 | | 6826 | | 7182 | | 7769 | | 8197 | |
| **Household Size** | | | | | | | | | | |
| Single Member | 1234 | (16.9) | 1375 | (20.1) | 1634 | (22.8) | 1772 | (22.8) | 1935 | (23.6) |
| Two Members | 2609 | (35.7) | 2543 | (37.3) | 2666 | (37.1) | 2878 | (37.0) | 3032 | (37.0) |
| Three Members | 1295 | (17.7) | 1133 | (16.6) | 1151 | (16.0) | 1234 | (15.9) | 1301 | (15.9) |
| Four Members | 1316 | (18.0) | 1045 | (15.3) | 1045 | (14.6) | 1147 | (14.8) | 1130 | (13.8) |
| Five Members | 561 | (7.7) | 480 | (7.0) | 463 | (6.5) | 481 | (6.2) | 521 | (6.4) |
| Six Members | 193 | (2.6) | 166 | (2.4) | 143 | (2.0) | 166 | (2.1) | 172 | (2.1) |
| Seven Members | 67 | (0.9) | 60 | (0.9) | 54 | (0.8) | 59 | (0.8) | 57 | (0.7) |
| Eight Members | 14 | (0.2) | 15 | (0.2) | 12 | (0.2) | 17 | (0.2) | 30 | (0.4) |
| Nine+ Members | 15 | (0.2) | 9 | (0.1) | 14 | (0.2) | 15 | (0.2) | 19 | (0.2) |
| **Household Income** | | | | | | | | | | |
| Under $5000 | 39 | (0.5) | 27 | (0.4) | 34 | (0.5) | 44 | (0.6) | 46 | (0.6) |
| $5000-$7999 | 48 | (0.7) | 66 | (1.0) | 66 | (0.9) | 83 | (1.1) | 76 | (0.9) |
| $8000-$9999 | 46 | (0.6) | 61 | (0.9) | 65 | (0.9) | 68 | (0.9) | 80 | (1.0) |
| $10,000-$11,999 | 63 | (0.9) | 89 | (1.3) | 94 | (1.3) | 113 | (1.5) | 120 | (1.5) |
| $12,000-$14,999 | 146 | (2.0) | 164 | (2.4) | 180 | (2.5) | 197 | (2.5) | 240 | (2.9) |
| $15,000-$19,999 | 294 | (4.0) | 345 | (5.1) | 386 | (5.4) | 441 | (5.7) | 411 | (5.0) |
| $20,000-$24,999 | 447 | (6.1) | 509 | (7.5) | 535 | (7.5) | 585 | (7.5) | 617 | (7.5) |
| $25,000-$29,999 | 481 | (6.6) | 484 | (7.1) | 446 | (6.2) | 512 | (6.6) | 544 | (6.6) |
| $30,000-$34,999 | 577 | (7.9) | 508 | (7.4) | 547 | (7.6) | 612 | (7.9) | 589 | (7.2) |
| $35,000-$39,999 | 564 | (7.7) | 471 | (6.9) | 495 | (6.9) | 511 | (6.6) | 574 | (7.0) |
| $40,000-$44,999 | 644 | (8.8) | 549 | (8.0) | 575 | (8.0) | 570 | (7.3) | 583 | (7.1) |
| $45,000-$49,999 | 565 | (7.7) | 462 | (6.8) | 539 | (7.5) | 508 | (6.5) | 576 | (7.0) |
| $50,000-$59,999 | 958 | (13.1) | 880 | (12.9) | 811 | (11.3) | 906 | (11.7) | 915 | (11.2) |
| $60,000-$69,999 | 769 | (10.5) | 691 | (10.1) | 711 | (9.9) | 806 | (10.4) | 757 | (9.2) |
| $70,000-$99,999 | 1145 | (15.7) | 1030 | (15.1) | 1127 | (15.7) | 1153 | (14.8) | 1274 | (15.5) |
| $100,000 & Over | 518 | (7.1) | 490 | (7.2) | 571 | (8.0) | 660 | (8.5) | 795 | (9.7) |
| **Presence of Children** | | | | | | | | | | |
| Yes | 2725 | (37.3) | 2237 | (32.8) | 2226 | (31.0) | 2418 | (31.1) | 2474 | (30.2) |
| No Children Under 18 | 4579 | (62.7) | 4589 | (67.2) | 4956 | (69.0) | 5351 | (68.9) | 5723 | (69.8) |

| Demographic Variable | 1998 Freq | 1998 (%) | 1999 Freq | 1999 (%) | 2000 Freq | 2000 (%) | 2001 Freq | 2001 (%) | 2002 Freq | 2002 (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age of Head** | | | | | | | | | | |
| Under 25 Years | 116 | (1.6) | 80 | (1.2) | 74 | (1.0) | 54 | (0.7) | 46 | (0.6) |
| 25-29 Years | 360 | (4.9) | 344 | (5.0) | 297 | (4.1) | 304 | (3.9) | 295 | (3.6) |
| 30-34 Years | 784 | (10.7) | 615 | (9.0) | 620 | (8.6) | 651 | (8.4) | 658 | (8.0) |
| 35-39 Years | 943 | (12.9) | 771 | (11.3) | 800 | (11.1) | 914 | (11.8) | 860 | (10.5) |
| 40-44 Years | 1123 | (15.4) | 962 | (14.1) | 966 | (13.5) | 982 | (12.6) | 1037 | (12.7) |
| 45-49 Years | 1108 | (15.2) | 998 | (14.6) | 1040 | (14.5) | 1061 | (13.7) | 1157 | (14.1) |
| 50-54 Years | 919 | (12.6) | 919 | (13.5) | 959 | (13.4) | 1066 | (13.7) | 1089 | (13.3) |
| 55-64 Years | 1162 | (15.9) | 1228 | (18.0) | 1360 | (18.9) | 1514 | (19.5) | 1695 | (20.7) |
| 65+ Years | 789 | (10.8) | 909 | (13.3) | 1066 | (14.8) | 1223 | (15.7) | 1360 | (16.6) |
| **Education of Head** | | | | | | | | | | |
| Grade School | 22 | (0.3) | 38 | (0.6) | 36 | (0.5) | 40 | (0.5) | 40 | (0.5) |
| Some High School | 158 | (2.2) | 201 | (2.9) | 210 | (2.9) | 248 | (3.2) | 273 | (3.3) |
| Graduated High School | 1583 | (21.7) | 1579 | (23.1) | 1825 | (25.4) | 1963 | (25.3) | 2008 | (24.5) |
| Some College | 2613 | (35.8) | 2314 | (33.9) | 2392 | (33.3) | 2549 | (32.8) | 2753 | (33.6) |
| Graduated College | 2064 | (28.3) | 1913 | (28.0) | 1930 | (26.9) | 2147 | (27.6) | 2275 | (27.8) |
| Post College Grad | 864 | (11.8) | 781 | (11.4) | 789 | (11.0) | 822 | (10.6) | 848 | (10.4) |
| **Race** | | | | | | | | | | |
| White | 6300 | (86.3) | 5747 | (84.2) | 5882 | (81.9) | 6228 | (80.2) | 6335 | (77.3) |
| Black | 613 | (8.4) | 696 | (10.2) | 832 | (11.6) | 1035 | (13.3) | 1152 | (14.1) |
| Oriental | 96 | (1.3) | 92 | (1.4) | 111 | (1.6) | 204 | (2.6) | 217 | (2.7) |
| Other | 295 | (4.0) | 291 | (4.3) | 357 | (5.0) | 302 | (3.9) | 493 | (6.0) |
| **Hispanic** | | | | | | | | | | |
| Yes | 530 | (7.3) | 525 | (7.7) | 475 | (6.6) | 561 | (7.2) | 640 | (7.8) |
| No | 6774 | (92.7) | 6301 | (92.3) | 6707 | (93.4) | 7208 | (92.8) | 7557 | (92.2) |
| **Region** | | | | | | | | | | |
| East | 1410 | (19.3) | 1372 | (20.1) | 1569 | (21.9) | 1705 | (22.0) | 1769 | (21.6) |
| Central | 1813 | (24.8) | 1737 | (25.5) | 1657 | (23.1) | 1554 | (20.0) | 1602 | (19.5) |
| South | 2550 | (34.9) | 2341 | (34.3) | 2337 | (32.5) | 2769 | (35.6) | 3063 | (37.4) |
| West | 1531 | (21.0) | 1376 | (20.2) | 1619 | (22.5) | 1741 | (22.4) | 1763 | (21.5) |
| **Major Market** | | | | | | | | | | |
| Yes | 4349 | (59.5) | 4105 | (60.1) | 4615 | (64.3) | 4885 | (62.9) | 5360 | (65.4) |
| No | 2955 | (40.5) | 2721 | (39.9) | 2567 | (35.7) | 2884 | (37.1) | 2837 | (34.6) |

| Demographic Variable | 2003 Freq | 2003 (%) | 2004 Freq | 2004 (%) | 2005 Freq | 2005 (%) | 2006 Freq | 2006 (%) | 2007 Freq | 2007 (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of Households** | 8337 | | 37592 | | 36839 | | 35600 | | 59384 | |
| **Household Size** | | | | | | | | | | |
| Single Member | 2057 | (24.7) | 9746 | (25.9) | 9535 | (25.9) | 9221 | (25.9) | 13198 | (22.2) |
| Two Members | 3193 | (38.3) | 14806 | (39.4) | 15078 | (40.9) | 15065 | (42.3) | 24612 | (41.5) |
| Three Members | 1286 | (15.4) | 5354 | (14.2) | 5225 | (14.2) | 4978 | (14.0) | 9263 | (15.6) |
| Four Members | 1072 | (12.9) | 4787 | (12.7) | 4303 | (11.7) | 4067 | (11.4) | 7618 | (12.8) |
| Five Members | 459 | (5.5) | 1932 | (5.1) | 1806 | (4.9) | 1527 | (4.3) | 3028 | (5.1) |
| Six Members | 167 | (2.0) | 675 | (1.8) | 585 | (1.6) | 494 | (1.4) | 1079 | (1.8) |
| Seven Members | 63 | (0.8) | 185 | (0.5) | 184 | (0.5) | 146 | (0.4) | 376 | (0.6) |
| Eight Members | 24 | (0.3) | 64 | (0.2) | 84 | (0.2) | 68 | (0.2) | 135 | (0.2) |
| Nine+ Members | 16 | (0.2) | 43 | (0.1) | 39 | (0.1) | 34 | (0.1) | 75 | (0.1) |
| **Household Income** | | | | | | | | | | |
| Under $5000 | 49 | (0.6) | 259 | (0.7) | 320 | (0.9) | 275 | (0.8) | 468 | (0.8) |
| $5000-$7999 | 90 | (1.1) | 492 | (1.3) | 414 | (1.1) | 405 | (1.1) | 604 | (1.0) |
| $8000-$9999 | 69 | (0.8) | 429 | (1.1) | 409 | (1.1) | 369 | (1.0) | 557 | (0.9) |
| $10,000-$11,999 | 142 | (1.7) | 626 | (1.7) | 617 | (1.7) | 519 | (1.5) | 870 | (1.5) |
| $12,000-$14,999 | 211 | (2.5) | 1143 | (3.0) | 1147 | (3.1) | 1056 | (3.0) | 1414 | (2.4) |
| $15,000-$19,999 | 439 | (5.3) | 2108 | (5.6) | 2003 | (5.4) | 1808 | (5.1) | 2382 | (4.0) |
| $20,000-$24,999 | 608 | (7.3) | 2968 | (7.9) | 2801 | (7.6) | 2511 | (7.1) | 3602 | (6.1) |
| $25,000-$29,999 | 505 | (6.1) | 2608 | (6.9) | 2524 | (6.9) | 2390 | (6.7) | 3793 | (6.4) |
| $30,000-$34,999 | 607 | (7.3) | 2967 | (7.9) | 2877 | (7.8) | 2643 | (7.4) | 4321 | (7.3) |
| $35,000-$39,999 | 569 | (6.8) | 2613 | (7.0) | 2530 | (6.9) | 2292 | (6.4) | 3870 | (6.5) |
| $40,000-$44,999 | 597 | (7.2) | 2592 | (6.9) | 2594 | (7.0) | 2409 | (6.8) | 3771 | (6.4) |
| $45,000-$49,999 | 540 | (6.5) | 2371 | (6.3) | 2335 | (6.3) | 2372 | (6.7) | 3732 | (6.3) |
| $50,000-$59,999 | 912 | (10.9) | 4121 | (11.0) | 3913 | (10.6) | 3628 | (10.2) | 6547 | (11.0) |
| $60,000-$69,999 | 784 | (9.4) | 3382 | (9.0) | 3215 | (8.7) | 3308 | (9.3) | 5247 | (8.8) |
| $70,000-$99,999 | 1411 | (16.9) | 5513 | (14.7) | 5568 | (15.1) | 5653 | (15.9) | 10795 | (18.2) |
| $100,000 & Over | 804 | (9.6) | 3400 | (9.0) | 3572 | (9.7) | 3962 | (11.1) | 7411 | (12.5) |
| **Presence of Children** | | | | | | | | | | |
| Yes | 2316 | (27.8) | 9495 | (25.3) | 8716 | (23.7) | 7872 | (22.1) | 15848 | (26.7) |
| No Children Under 18 | 6021 | (72.2) | 28097 | (74.7) | 28123 | (76.3) | 27728 | (77.9) | 43536 | (73.3) |

| Demographic Variable | 2003 Freq | 2003 (%) | 2004 Freq | 2004 (%) | 2005 Freq | 2005 (%) | 2006 Freq | 2006 (%) | 2007 Freq | 2007 (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age of Head** | | | | | | | | | | |
| Under 25 Years | 30 | (0.4) | 130 | (0.4) | 89 | (0.2) | 57 | (0.2) | 261 | (0.4) |
| 25-29 Years | 244 | (2.9) | 789 | (2.1) | 655 | (1.8) | 520 | (1.5) | 1610 | (2.7) |
| 30-34 Years | 575 | (6.9) | 1960 | (5.2) | 1651 | (4.5) | 1366 | (3.8) | 3352 | (5.6) |
| 35-39 Years | 817 | (9.8) | 3024 | (8.0) | 2728 | (7.4) | 2401 | (6.7) | 4927 | (8.3) |
| 40-44 Years | 1032 | (12.4) | 4329 | (11.5) | 4102 | (11.1) | 3698 | (10.4) | 6559 | (11.1) |
| 45-49 Years | 1139 | (13.7) | 5056 | (13.5) | 4860 | (13.2) | 4663 | (13.1) | 8165 | (13.8) |
| 50-54 Years | 1124 | (13.5) | 4939 | (13.1) | 5032 | (13.7) | 5025 | (14.1) | 8620 | (14.5) |
| 55-64 Years | 1857 | (22.3) | 8490 | (22.6) | 8734 | (23.7) | 8948 | (25.1) | 14541 | (24.5) |
| 65+ Years | 1519 | (18.2) | 8875 | (23.6) | 8988 | (24.4) | 8922 | (25.1) | 11349 | (19.1) |
| **Education of Head** | | | | | | | | | | |
| Grade School | 53 | (0.6) | 220 | (0.6) | 203 | (0.6) | 188 | (0.5) | 267 | (0.5) |
| Some High School | 245 | (2.9) | 1230 | (3.3) | 1128 | (3.1) | 1066 | (3.0) | 1527 | (2.6) |
| Graduated High School | 1995 | (23.9) | 10359 | (27.6) | 9924 | (26.9) | 9552 | (26.8) | 15495 | (26.1) |
| Some College | 2836 | (34.0) | 12070 | (32.1) | 11827 | (32.1) | 11222 | (31.5) | 19048 | (32.1) |
| Graduated College | 2301 | (27.6) | 9796 | (26.1) | 9854 | (26.8) | 9636 | (27.1) | 16763 | (28.2) |
| Post College Grad | 907 | (10.9) | 3917 | (10.4) | 3903 | (10.6) | 3936 | (11.1) | 6284 | (10.6) |
| **Race** | | | | | | | | | | |
| White | 6416 | (77.0) | 30966 | (82.4) | 30565 | (83.0) | 29640 | (83.3) | 50082 | (84.3) |
| Black | 1139 | (13.7) | 3699 | (9.8) | 3514 | (9.5) | 3409 | (9.6) | 5229 | (8.8) |
| Oriental | 236 | (2.8) | 805 | (2.1) | 797 | (2.2) | 823 | (2.3) | 1357 | (2.3) |
| Other | 546 | (6.6) | 2122 | (5.6) | 1963 | (5.3) | 1728 | (4.9) | 2716 | (4.6) |
| **Hispanic** | | | | | | | | | | |
| Yes | 711 | (8.5) | 2447 | (6.5) | 2331 | (6.3) | 2132 | (6.0) | 3142 | (5.3) |
| No | 7626 | (91.5) | 35145 | (93.5) | 34508 | (93.7) | 33468 | (94.0) | 56242 | (94.7) |
| **Region** | | | | | | | | | | |
| East | 1772 | (21.3) | 6090 | (16.2) | 5845 | (15.9) | 5667 | (15.9) | 9809 | (16.5) |
| Central | 1502 | (18.0) | 8785 | (23.4) | 8733 | (23.7) | 8480 | (23.8) | 16320 | (27.5) |
| South | 3320 | (39.8) | 14458 | (38.5) | 14463 | (39.3) | 13973 | (39.3) | 21691 | (36.5) |
| West | 1743 | (20.9) | 8259 | (22.0) | 7798 | (21.2) | 7480 | (21.0) | 11564 | (19.5) |
| **Major Market** | | | | | | | | | | |
| Yes | 5546 | (66.5) | 23729 | (63.1) | 23233 | (63.1) | 22536 | (63.3) | 29643 | (49.9) |
| No | 2791 | (33.5) | 13863 | (36.9) | 13606 | (36.9) | 13064 | (36.7) | 29741 | (50.1) |

## Appendix B. List of Newspapers in the United States by Circulation (Top 100)

| Rank | Newspaper | Circulation | Rank | Newspaper | Circulation |
|---|---|---|---|---|---|
| 1 | USA Today (Arlington, Va.) | 2,528,437 | 26 | Journal Sentinel (Milwaukee) | 405,355 |
| 2 | Wall Street Journal (New York, N.Y.) | 2,058,342 | 27 | Sun (Baltimore) | 401,918 |
| 3 | Times (New York, N.Y.) | 1,683,855 | 28 | Herald (Miami) | 390,171 |
| 4 | Times (Los Angeles) | 1,231,318 | 29 | Oregonian (Portland) | 384,729 |
| 5 | Post (Washington, DC) | 960,684 | 30 | Post-Gazette (Pittsburgh, Pa.) | 373,980 |
| 6 | Tribune (Chicago) | 957,212 | 31 | Star (Kansas City, Mo.) | 367,712 |
| 7 | Daily News (New York, N.Y.) | 795,153 | 32 | Register (Orange County, Calif.) | 354,632 |
| 8 | Inquirer (Philadelphia) | 705,965 | 33 | Dispatch (Columbus, Ohio) | 352,510 |
| 9 | Post/Rocky Mountain News (Denver) | 704,806 | 34 | Star (Indianapolis) | 347,217 |
| 10 | Chronicle (Houston) | 692,557 | 35 | Express-News (San Antonio, Tex.) | 342,709 |
| 11 | Post (New York, N.Y.) | 691,420 | 36 | Sentinel (Orlando, Fla.) | 341,025 |
| 12 | News/Free Press (Detroit) | 669,315 | 37 | South Florida Sun-Sentinel (Fort Lauderdale, Fla.) | 339,728 |
| 13 | Morning News (Dallas) | 649,709 | 38 | Bee (Sacramento, Calif.) | 330,993 |
| 14 | Star Tribune (Minneapolis) | 606,698 | 39 | Star-Telegram (Fort Worth, Tex.) | 322,824 |
| 15 | Globe (Boston) | 604,068 | 40 | Tribune & Times (Tampa, Fla.) | 309,916 |
| 16 | Star-Ledger (Newark, N.J.) | 599,628 | 41 | Enquirer/Post (Cincinnati) | 293,151 |
| 17 | Journal-Constitution (Atlanta) | 561,405 | 42 | Daily Oklahoman (Oklahoma City) | 287,505 |
| 18 | Arizona Republic (Phoenix) | 556,465 | 43 | Democrat-Gazette (Little Rock, Ark.) | 275,991 |
| 19 | Newsday (Long Island, N.Y.) | 488,825 | 44 | Observer (Charlotte, N.C.) | 274,125 |
| 20 | Chronicle (San Francisco) | 451,504 | 45 | News (Buffalo, N.Y.) | 273,177 |
| 21 | Plain Dealer (Cleveland) | 450,875 | 46 | Courant (Hartford, Conn.) | 272,918 |
| 22 | Times/Post-Intelligencer (Seattle) | 435,581 | 47 | Courier-Journal (Louisville, Ky.) | 271,920 |
| 23 | Post-Dispatch (St. Louis) | 423,291 | 48 | Mercury News (San Jose, Calif.) | 263,373 |
| 24 | Times (St. Petersburg, Fla.) | 422,410 | 49 | Pioneer Press (St. Paul, Minn.) | 251,565 |
| 25 | Union-Tribune (San Diego) | 408,392 | 50 | Register (Des Moines, Iowa) | 240,912 |

NOTE: By largest reported circulation, as of March 31, 2006.
Source: Audit Bureau Circulation, extracted from Information Please® Database, © 2007 Pearson Education, Inc.

| Rank | Newspaper | Circulation | Rank | Newspaper | Circulation |
|---|---|---|---|---|---|
| 51 | Tennessean (Nashville) | 236,563 | 76 | Post-Standard (Syracuse, N.Y.) | 168,393 |
| 52 | World-Herald (Omaha, Neb.) | 231,115 | 77 | Blade (Toledo, Ohio) | 167,686 |
| 53 | Herald (Boston) | 230,344 | 78 | Advertiser (Honolulu) | 160,723 |
| 54 | American-Statesman (Austin, Tex.) | 228,619 | 79 | Tribune-Review (Greensburg, Pa.) | 158,013 |
| 55 | Virginian-Pilot (Norfolk, Va.) | 225,730 | 80 | Daily Herald (Arlington Heights, Ill.) | 153,291 |
| 56 | Times-Union (Jacksonville, Fla.) | 222,392 | 81 | News-sentinel (Knoxville, Tenn.) | 152,945 |
| 57 | Democrat and Chronicle (Rochester, N.Y.) | 219,660 | 82 | Tribune/Deseret News (Salt Lake City) | 151,422 |
| 58 | Times-Dispatch (Richmond, Va.) | 219,595 | 83 | Morning Call (Allentown, Pa.) | 150,936 |
| 59 | Review-Journal (Las Vegas) | 219,228 | 84 | Journal (Albuquerque) | 149,455 |
| 60 | Journal (Providence, R.I.) | 218,388 | 85 | Wisconsin State Journal/Capital Times (Madison, Wis.) | 148,489 |
| 61 | Commercial Appeal (Memphis) | 216,705 | 86 | Patriot-News (Harrisburg, Pa.) | 148,301 |
| 62 | News & Observer (Raleigh, N.C.) | 213,878 | 87 | Journal News (White Plains, N.Y.) | 144,231 |
| 63 | Post (W. Palm Beach, Fla.) | 211,697 | 88 | Eagle (Wichita, Kans.) | 143,948 |
| 64 | Investors Business Daily (Los Angeles) | 210,708 | 89 | Herald-Leader (Lexington, Ky.) | 141,019 |
| 65 | Record (Hackensack, N.J.) | 206,086 | 90 | State (Columbia, S.C.) | 140,362 |
| 66 | Asbury Park Press (Neptune, N.J.) | 199,723 | 91 | Herald-Tribune (Sarasota, Fla.) | 138,675 |
| 67 | Contra Costa Times (Walnut Creek, Calif.) | 190,613 | 92 | News Tribune (Tacoma, Wash.) | 137,730 |
| 68 | Press-Enterprise (Riverside, Calif.) | 189,000 | 93 | News Journal (Wilmington, Del.) | 134,865 |
| 69 | Daily News (Los Angeles) | 187,740 | 94 | Times Union (Albany, N.Y.) | 133,787 |
| 70 | Bee (Fresno, Calif.) | 183,744 | 95 | La Opinion (Los Angeles) | 128,553 |
| 71 | Press (Grand Rapids, Mich.) | 182,810 | 96 | Republican (Springfield, Mass.) | 125,864 |
| 72 | News (Birmingham, Ala.) | 180,451 | 97 | News-Journal (Daytona Beach, Fla.) | 125,754 |
| 73 | Daily Star (Tucson, Ariz.) | 173,064 | 98 | Daily News (Philadelphia) | 123,483 |
| 74 | Beacon Journal (Akron, Ohio) | 170,870 | 99 | Journal Gazette/News-Sentinel (Fort Wayne, Ind.) | 121,475 |
| 75 | Daily News (Dayton, Ohio) | 168,645 | 100 | Spokesman-Review (Spokane, Wash.) | 120,632 |

NOTE: By largest reported circulation, as of March 31, 2006.
Source: Audit Bureau Circulation, extracted from Information Please® Database, © 2007 Pearson Education, Inc.

## Appendix C. List of Consumer Magazines in the United States by Circulation (Top 100)

| Rank | Magazine | Circulation (Paid) | Rank | Magazine | Circulation (Paid) |
|---|---|---|---|---|---|
| 1 | AARP the Magazine | 22,675,655 | 26 | Redbook | 2,412,882 |
| 2 | AARP Bulletin | 22,075,011 | 27 | Glamour | 2,371,986 |
| 3 | Reader's Digest | 10,111,773 | 28 | AAA Living | 2,167,800 |
| 4 | TV Guide | 8,211,581 | 29 | Parents | 2,049,100 |
| 5 | Better Homes & Gardens | 7,620,932 | 30 | Smithsonian | 2,048,322 |
| 6 | National Geographic | 5,403,934 | 31 | Seventeen | 2,034,462 |
| 7 | Good Housekeeping | 4,634,763 | 32 | U.S. News & World Report | 2,028,167 |
| 8 | Family Circle | 4,296,370 | 33 | Parenting | 1,972,595 |
| 9 | Ladies' Home Journal | 4,122,460 | 34 | Money | 1,968,211 |
| 10 | Woman's Day | 4,048,799 | 35 | Martha Stewart Living | 1,950,482 |
| 11 | TIME—The Weekly Newsmagazine | 4,038,508 | 36 | Game Informer Magazine | 1,934,859 |
| 12 | People | 3,734,536 | 37 | Real Simple | 1,900,676 |
| 13 | AAA Westways | 3,676,058 | 38 | ESPN the Magazine | 1,876,136 |
| 14 | Prevention | 3,338,450 | 39 | Entertainment Weekly | 1,803,793 |
| 15 | Sports Illustrated | 3,289,656 | 40 | Home & Away | 1,801,441 |
| 16 | Newsweek | 3,158,988 | 41 | In Style | 1,783,235 |
| 17 | Playboy | 3,060,376 | 42 | FamilyFun | 1,781,451 |
| 18 | Cosmopolitan | 2,969,952 | 43 | Men's Health | 1,774,558 |
| 19 | Southern Living | 2,745,663 | 44 | Cooking Light | 1,732,001 |
| 20 | Guideposts | 2,640,471 | 45 | Country Living | 1,723,740 |
| 21 | American Legion Magazine | 2,528,853 | 46 | Endless Vacation | 1,716,213 |
| 22 | Maxim | 2,517,450 | 47 | US Weekly | 1,668,135 |
| 23 | O, the Oprah Magazine | 2,513,318 | 48 | Shape | 1,655,330 |
| 24 | AAA Going Places | 2,450,540 | 49 | Golf Digest | 1,582,770 |
| 25 | Via Magazine | 2,435,904 | 50 | Woman's World | 1,575,214 |

NOTE: Circulation in 2005.

Source: Audit Bureau Circulation, extracted from Information Please® Database, © 2007 Pearson Education, Inc.

| Rank | Magazine | Circulation (Paid) | Rank | Magazine | Circulation (Paid) |
|---|---|---|---|---|---|
| 51 | VFW Magazine | 1,561,257 | 76 | Boys' Life | 1,220,774 |
| 52 | Field & Stream | 1,538,018 | 77 | Popular Mechanics | 1,216,268 |
| 53 | Teen People | 1,525,409 | 78 | Vanity Fair | 1,172,734 |
| 54 | Fitness | 1,506,002 | 79 | Family Handyman | 1,150,770 |
| 55 | Ebony | 1,486,120 | 80 | In Touch Weekly | 1,150,735 |
| 56 | Popular Science | 1,468,386 | 81 | Motor Trend | 1,119,803 |
| 57 | First for Women | 1,461,657 | 82 | More | 1,085,681 |
| 58 | Sunset | 1,458,628 | 83 | Lucky | 1,066,408 |
| 59 | Star Magazine | 1,428,767 | 84 | Essence | 1,060,613 |
| 60 | Golf Magazine | 1,421,014 | 85 | Allure | 1,060,099 |
| 61 | Teen Vogue | 1,410,609 | 86 | Elle | 1,054,447 |
| 62 | Self | 1,410,476 | 87 | New Yorker | 1,053,019 |
| 63 | Cosmo Girl! | 1,383,468 | 88 | Scouting | 1,020,466 |
| 64 | American Rifleman | 1,374,970 | 89 | Home | 1,016,043 |
| 65 | Health | 1,368,162 | 90 | American Hunter | 988,817 |
| 66 | Car and Driver | 1,354,146 | 91 | BusinessWeek | 986,549 |
| 67 | Stuff | 1,333,768 | 92 | Gourmet | 981,221 |
| 68 | Bon Appetit | 1,325,475 | 93 | Traditional Home | 978,892 |
| 69 | Rolling Stone | 1,309,117 | 94 | This Old House | 968,603 |
| 70 | Country Home | 1,286,239 | 95 | Travel + Leisure | 968,175 |
| 71 | FHM (For Him Magazine) | 1,277,511 | 96 | Marie Claire | 960,900 |
| 72 | Vogue | 1,260,316 | 97 | Jet | 956,909 |
| 73 | Weight Watchers | 1,255,634 | 98 | Outdoor Life | 949,447 |
| 74 | National Enquirer | 1,239,211 | 99 | Midwest Living | 947,888 |
| 75 | Scholastic Parent & Child | 1,238,983 | 100 | Forbes | 926,581 |

NOTE: Circulation in 2005.

Source: Audit Bureau Circulation, extracted from Information Please® Database, © 2007 Pearson Education, Inc.

## Appendix D. LexisNexis® Search Procedure

(1) Login LexisNexis® and select "Power Search" from the left side of the screen.

(2) Type keywords "(omega 3 or DHA or fish oil or flaxseed oil or flax seed oil or linseed oil) and health!" in "Search Terms."

(3) Select source for the following four media types.

  a) Newspapers and newswires: select "U.S. newspapers and newswires"

  b) TV and radio: select "Transcript" and add the keyword "and geographic (United States). Since the target is the consumers in the United States, articles are restricted by the geographic keywords.

  c) For magazines, select "Magazine stories, combined" and add the keyword "and geographic (United States)"

(4) Specify date between 01/01/1998 and 12/31/2007.

(5) Click "search" button. If the search will return more than 3,000 results, the search is interrupted and prompted to narrow the search. In reality, the results are more than 3,000 for all the media if the whole period is specified. Therefore, more specific date (usually monthly) is used to retrieve the sample.

(6) Download the results. Taking into account the fact that the results will be analyzed by InfoTrend® software later, the results are downloaded as a text file each containing maximum 500 stories for the sake of convenience. If there are more than 500 stories, separate files are made for them.

## Appendix E. Media Index for the Idea of "Health"

| Year | Month | Raw Score(X) NW | TR | MZ | Standardized Score (Z) NW | TR | MZ | Media Index (S) | Discounted Media Index (T) |
|---|---|---|---|---|---|---|---|---|---|
| 1998 | 1 | 27 | 6 | 2 | 11.0 | 16.2 | 8.0 | 11.5 | |
| 1998 | 2 | 24 | 1 | 4 | 9.3 | 2.7 | 16.0 | 9.8 | |
| 1998 | 3 | 19 | 0 | 2 | 6.6 | 0.0 | 8.0 | 5.0 | |
| 1998 | 4 | 15 | 4 | 6 | 4.4 | 10.8 | 24.0 | 14.1 | |
| 1998 | 5 | 20 | 1 | 6 | 7.1 | 2.7 | 24.0 | 12.3 | |
| 1998 | 6 | 23 | 0 | 1 | 8.8 | 0.0 | 4.0 | 4.1 | 33.3 |
| 1998 | 7 | 9 | 0 | 9 | 1.1 | 0.0 | 36.0 | 14.4 | 38.0 |
| 1998 | 8 | 27 | 2 | 2 | 11.0 | 5.4 | 8.0 | 8.0 | 35.9 |
| 1998 | 9 | 44 | 4 | 25 | 20.3 | 10.8 | 100.0 | 48.4 | 75.7 |
| 1998 | 10 | 22 | 1 | 3 | 8.2 | 2.7 | 12.0 | 7.9 | 64.8 |
| 1998 | 11 | 28 | 6 | 8 | 11.5 | 16.2 | 32.0 | 21.0 | 69.7 |
| 1998 | 12 | 20 | 0 | 10 | 7.1 | 0.0 | 40.0 | 17.7 | 72.3 |
| 1999 | 1 | 15 | 2 | 0 | 4.4 | 5.4 | 0.0 | 3.0 | 57.1 |
| 1999 | 2 | 8 | 0 | 6 | 0.5 | 0.0 | 24.0 | 9.5 | 53.1 |
| 1999 | 3 | 85 | 0 | 3 | 42.9 | 0.0 | 12.0 | 17.1 | 46.9 |
| 1999 | 4 | 22 | 0 | 1 | 8.2 | 0.0 | 4.0 | 4.0 | 39.4 |
| 1999 | 5 | 43 | 0 | 10 | 19.8 | 0.0 | 40.0 | 21.3 | 47.3 |
| 1999 | 6 | 7 | 1 | 1 | 0.0 | 2.7 | 4.0 | 2.4 | 35.7 |
| 1999 | 7 | 12 | 0 | 7 | 2.7 | 0.0 | 28.0 | 11.7 | 39.5 |
| 1999 | 8 | 69 | 3 | 4 | 34.1 | 8.1 | 16.0 | 18.7 | 47.8 |
| 1999 | 9 | 32 | 0 | 2 | 13.7 | 0.0 | 8.0 | 7.1 | 40.8 |
| 1999 | 10 | 60 | 2 | 6 | 29.1 | 5.4 | 24.0 | 19.5 | 51.2 |
| 1999 | 11 | 25 | 2 | 1 | 9.9 | 5.4 | 4.0 | 6.2 | 41.5 |
| 1999 | 12 | 21 | 0 | 2 | 7.7 | 0.0 | 8.0 | 5.4 | 37.9 |
| 2000 | 1 | 18 | 1 | 4 | 6.0 | 2.7 | 16.0 | 8.9 | 36.1 |
| 2000 | 2 | 36 | 0 | 1 | 15.9 | 0.0 | 4.0 | 6.2 | 30.2 |
| 2000 | 3 | 39 | 0 | 4 | 17.6 | 0.0 | 16.0 | 11.3 | 33.6 |
| 2000 | 4 | 26 | 3 | 6 | 10.4 | 8.1 | 24.0 | 15.0 | 36.8 |
| 2000 | 5 | 31 | 0 | 0 | 13.2 | 0.0 | 0.0 | 3.8 | 31.6 |
| 2000 | 6 | 23 | 1 | 3 | 8.8 | 2.7 | 12.0 | 8.1 | 32.0 |
| 2000 | 7 | 30 | 1 | 7 | 12.6 | 2.7 | 28.0 | 15.4 | 38.7 |
| 2000 | 8 | 26 | 0 | 7 | 10.4 | 0.0 | 28.0 | 13.9 | 43.3 |
| 2000 | 9 | 27 | 0 | 1 | 11.0 | 0.0 | 4.0 | 4.7 | 36.4 |
| 2000 | 10 | 27 | 2 | 2 | 11.0 | 5.4 | 8.0 | 8.0 | 33.2 |
| 2000 | 11 | 49 | 0 | 1 | 23.1 | 0.0 | 4.0 | 8.3 | 33.8 |
| 2000 | 12 | 12 | 0 | 5 | 2.7 | 0.0 | 20.0 | 8.6 | 33.5 |
| 2001 | 1 | 39 | 3 | 4 | 17.6 | 8.1 | 16.0 | 13.9 | 36.7 |
| 2001 | 2 | 20 | 1 | 9 | 7.1 | 2.7 | 36.0 | 17.0 | 42.7 |
| 2001 | 3 | 56 | 3 | 9 | 26.9 | 8.1 | 36.0 | 24.4 | 57.4 |

NR: Newspaper & Newswires, TR: TV & Radio, MZ: Magazines

| Year | Month | Raw Score(X) NW | TR | MZ | standardized Score (Z) NW | TR | MZ | Media Index(S) | Discounted Media Index (T) |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 4 | 40 | 0 | 10 | 18.1 | 0.0 | 40.0 | 20.9 | 64.6 |
| 2001 | 5 | 31 | 1 | 0 | 13.2 | 2.7 | 0.0 | 4.7 | 54.2 |
| 2001 | 6 | 42 | 0 | 1 | 19.2 | 0.0 | 4.0 | 7.1 | 48.3 |
| 2001 | 7 | 62 | 0 | 6 | 30.2 | 0.0 | 24.0 | 18.1 | 53.1 |
| 2001 | 8 | 51 | 0 | 3 | 24.2 | 0.0 | 12.0 | 11.7 | 49.7 |
| 2001 | 9 | 48 | 0 | 2 | 22.5 | 0.0 | 8.0 | 9.7 | 43.0 |
| 2001 | 10 | 42 | 0 | 3 | 19.2 | 0.0 | 12.0 | 10.3 | 39.2 |
| 2001 | 11 | 20 | 1 | 2 | 7.1 | 2.7 | 8.0 | 6.1 | 36.2 |
| 2001 | 12 | 17 | 0 | 7 | 5.5 | 0.0 | 28.0 | 12.5 | 39.6 |
| 2002 | 1 | 31 | 0 | 6 | 13.2 | 0.0 | 24.0 | 13.2 | 40.1 |
| 2002 | 2 | 37 | 0 | 0 | 16.5 | 0.0 | 0.0 | 4.8 | 33.8 |
| 2002 | 3 | 30 | 3 | 5 | 12.6 | 8.1 | 20.0 | 14.1 | 38.6 |
| 2002 | 4 | 140 | 3 | 3 | 73.1 | 8.1 | 12.0 | 28.5 | 56.6 |
| 2002 | 5 | 67 | 1 | 3 | 33.0 | 2.7 | 12.0 | 15.1 | 58.8 |
| 2002 | 6 | 25 | 0 | 12 | 9.9 | 0.0 | 48.0 | 21.6 | 65.4 |
| 2002 | 7 | 47 | 0 | 2 | 22.0 | 0.0 | 8.0 | 9.5 | 58.3 |
| 2002 | 8 | 42 | 0 | 19 | 19.2 | 0.0 | 76.0 | 35.2 | 80.6 |
| 2002 | 9 | 33 | 1 | 4 | 14.3 | 2.7 | 16.0 | 11.2 | 72.1 |
| 2002 | 10 | 41 | 0 | 3 | 18.7 | 0.0 | 12.0 | 10.1 | 60.3 |
| 2002 | 11 | 64 | 8 | 1 | 31.3 | 21.6 | 4.0 | 17.6 | 61.8 |
| 2002 | 12 | 60 | 1 | 10 | 29.1 | 2.7 | 40.0 | 24.9 | 68.7 |
| 2003 | 1 | 43 | 1 | 1 | 19.8 | 2.7 | 4.0 | 8.2 | 60.6 |
| 2003 | 2 | 32 | 0 | 1 | 13.7 | 0.0 | 4.0 | 5.5 | 44.8 |
| 2003 | 3 | 75 | 1 | 20 | 37.4 | 2.7 | 80.0 | 42.9 | 75.8 |
| 2003 | 4 | 36 | 1 | 1 | 15.9 | 2.7 | 4.0 | 7.0 | 65.0 |
| 2003 | 5 | 78 | 5 | 5 | 39.0 | 13.5 | 20.0 | 23.4 | 70.9 |
| 2003 | 6 | 56 | 0 | 5 | 26.9 | 0.0 | 20.0 | 15.6 | 65.8 |
| 2003 | 7 | 113 | 6 | 14 | 58.2 | 16.2 | 56.0 | 43.9 | 94.4 |
| 2003 | 8 | 67 | 2 | 5 | 33.0 | 5.4 | 20.0 | 19.1 | 93.2 |
| 2003 | 9 | 45 | 0 | 3 | 20.9 | 0.0 | 12.0 | 10.7 | 74.0 |
| 2003 | 10 | 40 | 2 | 2 | 18.1 | 5.4 | 8.0 | 10.1 | 67.5 |
| 2003 | 11 | 74 | 3 | 4 | 36.8 | 8.1 | 16.0 | 19.5 | 67.3 |
| 2003 | 12 | 78 | 5 | 7 | 39.0 | 13.5 | 28.0 | 26.6 | 76.3 |
| 2004 | 1 | 90 | 10 | 16 | 45.6 | 27.0 | 64.0 | 46.8 | 96.4 |
| 2004 | 2 | 143 | 3 | 10 | 74.7 | 8.1 | 40.0 | 39.9 | 112.0 |
| 2004 | 3 | 101 | 2 | 8 | 51.6 | 5.4 | 32.0 | 29.2 | 116.0 |
| 2004 | 4 | 88 | 2 | 5 | 44.5 | 5.4 | 20.0 | 22.4 | 112.6 |
| 2004 | 5 | 61 | 0 | 19 | 29.7 | 0.0 | 76.0 | 38.2 | 123.2 |
| 2004 | 6 | 79 | 0 | 3 | 39.6 | 0.0 | 12.0 | 16.2 | 107.7 |
| 2004 | 7 | 42 | 3 | 6 | 19.2 | 8.1 | 24.0 | 17.5 | 91.4 |
| 2004 | 8 | 56 | 4 | 11 | 26.9 | 10.8 | 44.0 | 28.4 | 91.1 |

NR: Newspaper & Newswires, TR: TV & Radio, MZ: Magazines

| Year | Month | Raw Score(X) NW | TR | MZ | Standardized Score (Z) NW | TR | MZ | Media Index (S) | Discounted Media Index (T) |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 9 | 179 | 1 | 9 | 94.5 | 2.7 | 36.0 | 42.3 | 107.6 |
| 2004 | 10 | 76 | 0 | 11 | 37.9 | 0.0 | 44.0 | 28.2 | 108.3 |
| 2004 | 11 | 75 | 3 | 4 | 37.4 | 8.1 | 16.0 | 19.7 | 96.3 |
| 2004 | 12 | 50 | 2 | 2 | 23.6 | 5.4 | 8.0 | 11.7 | 84.5 |
| 2005 | 1 | 91 | 3 | 7 | 46.2 | 8.1 | 28.0 | 26.9 | 89.9 |
| 2005 | 2 | 76 | 5 | 13 | 37.9 | 13.5 | 52.0 | 35.6 | 100.1 |
| 2005 | 3 | 96 | 6 | 10 | 48.9 | 16.2 | 40.0 | 35.0 | 103.9 |
| 2005 | 4 | 79 | 2 | 10 | 39.6 | 5.4 | 40.0 | 28.8 | 104.6 |
| 2005 | 5 | 102 | 9 | 11 | 52.2 | 24.3 | 44.0 | 40.1 | 118.6 |
| 2005 | 6 | 72 | 1 | 8 | 35.7 | 2.7 | 32.0 | 23.7 | 115.5 |
| 2005 | 7 | 59 | 1 | 6 | 28.6 | 2.7 | 24.0 | 18.5 | 103.9 |
| 2005 | 8 | 94 | 1 | 11 | 47.8 | 2.7 | 44.0 | 31.9 | 105.6 |
| 2005 | 9 | 75 | 0 | 4 | 37.4 | 0.0 | 16.0 | 17.1 | 92.4 |
| 2005 | 10 | 138 | 5 | 9 | 72.0 | 13.5 | 36.0 | 39.2 | 105.6 |
| 2005 | 11 | 76 | 2 | 17 | 37.9 | 5.4 | 68.0 | 39.2 | 113.2 |
| 2005 | 12 | 59 | 1 | 21 | 28.6 | 2.7 | 84.0 | 41.9 | 126.3 |
| 2006 | 1 | 112 | 17 | 7 | 57.7 | 45.9 | 28.0 | 42.4 | 138.5 |
| 2006 | 2 | 88 | 8 | 10 | 44.5 | 21.6 | 40.0 | 35.4 | 137.9 |
| 2006 | 3 | 189 | 12 | 6 | 100.0 | 32.4 | 24.0 | 48.7 | 154.6 |
| 2006 | 4 | 102 | 7 | 24 | 52.2 | 18.9 | 96.0 | 58.6 | 172.0 |
| 2006 | 5 | 72 | 0 | 10 | 35.7 | 0.0 | 40.0 | 26.0 | 153.3 |
| 2006 | 6 | 89 | 2 | 7 | 45.1 | 5.4 | 28.0 | 25.7 | 137.3 |
| 2006 | 7 | 83 | 1 | 4 | 41.8 | 2.7 | 16.0 | 19.2 | 118.0 |
| 2006 | 8 | 105 | 2 | 6 | 53.8 | 5.4 | 24.0 | 26.7 | 111.8 |
| 2006 | 9 | 74 | 1 | 25 | 36.8 | 2.7 | 100.0 | 50.5 | 127.2 |
| 2006 | 10 | 172 | 9 | 16 | 90.7 | 24.3 | 64.0 | 59.0 | 145.4 |
| 2006 | 11 | 107 | 18 | 15 | 54.9 | 48.6 | 60.0 | 54.9 | 164.4 |
| 2006 | 12 | 75 | 19 | 10 | 37.4 | 51.4 | 40.0 | 42.9 | 167.7 |
| 2007 | 1 | 108 | 37 | 11 | 55.5 | 100.0 | 44.0 | 65.3 | 194.4 |
| 2007 | 2 | 110 | 4 | 13 | 56.6 | 10.8 | 52.0 | 40.2 | 188.6 |
| 2007 | 3 | 123 | 9 | 0 | 63.7 | 24.3 | 0.0 | 26.3 | 163.9 |
| 2007 | 4 | 99 | 19 | 7 | 50.5 | 51.4 | 28.0 | 42.0 | 157.7 |
| 2007 | 5 | 127 | 1 | 12 | 65.9 | 2.7 | 48.0 | 38.7 | 150.5 |
| 2007 | 6 | 97 | 8 | 19 | 49.5 | 21.6 | 76.0 | 50.9 | 160.0 |
| 2007 | 7 | 70 | 1 | 24 | 34.6 | 2.7 | 96.0 | 48.3 | 159.3 |
| 2007 | 8 | 73 | 3 | 5 | 36.3 | 8.1 | 20.0 | 20.9 | 137.8 |
| 2007 | 9 | 55 | 6 | 5 | 26.4 | 16.2 | 20.0 | 20.6 | 124.0 |
| 2007 | 10 | 103 | 2 | 14 | 52.7 | 5.4 | 56.0 | 38.9 | 127.0 |
| 2007 | 11 | 78 | 11 | 3 | 39.0 | 29.7 | 12.0 | 25.5 | 117.0 |
| 2007 | 12 | 60 | 1 | 13 | 29.1 | 2.7 | 52.0 | 29.6 | 109.8 |

NR: Newspaper & Newswires, TR: TV & Radio, MZ: Magazines

## Appendix F. Media Index for the Idea of "Development"

| Year | Month | Raw Score(X) NW | TR | MZ | Standardiized Score (Z) NW | TR | MZ | Media Index (S) | Discounted Media Index (T) |
|---|---|---|---|---|---|---|---|---|---|
| 1998 | 1 | 5 | 2 | 0 | 10.0 | 28.6 | 0.0 | 12.0 | |
| 1998 | 2 | 4 | 0 | 1 | 8.0 | 0.0 | 14.3 | 7.9 | |
| 1998 | 3 | 8 | 0 | 1 | 16.0 | 0.0 | 14.3 | 10.2 | |
| 1998 | 4 | 1 | 0 | 1 | 2.0 | 0.0 | 14.3 | 6.2 | |
| 1998 | 5 | 7 | 0 | 0 | 14.0 | 0.0 | 0.0 | 4.1 | |
| 1998 | 6 | 6 | 0 | 0 | 12.0 | 0.0 | 0.0 | 3.5 | 23.1 |
| 1998 | 7 | 4 | 0 | 1 | 8.0 | 0.0 | 14.3 | 7.9 | 23.2 |
| 1998 | 8 | 15 | 0 | 1 | 30.0 | 0.0 | 14.3 | 14.3 | 30.8 |
| 1998 | 9 | 20 | 1 | 0 | 40.0 | 14.3 | 0.0 | 16.2 | 38.1 |
| 1998 | 10 | 13 | 0 | 1 | 26.0 | 0.0 | 14.3 | 13.1 | 42.0 |
| 1998 | 11 | 1 | 1 | 3 | 2.0 | 14.3 | 42.9 | 21.9 | 54.4 |
| 1998 | 12 | 8 | 0 | 1 | 16.0 | 0.0 | 14.3 | 10.2 | 52.8 |
| 1999 | 1 | 1 | 0 | 0 | 2.0 | 0.0 | 0.0 | 0.6 | 40.8 |
| 1999 | 2 | 1 | 0 | 0 | 2.0 | 0.0 | 0.0 | 0.6 | 29.4 |
| 1999 | 3 | 7 | 0 | 0 | 14.0 | 0.0 | 0.0 | 4.1 | 23.4 |
| 1999 | 4 | 8 | 0 | 0 | 16.0 | 0.0 | 0.0 | 4.6 | 19.9 |
| 1999 | 5 | 4 | 0 | 1 | 8.0 | 0.0 | 14.3 | 7.9 | 18.1 |
| 1999 | 6 | 19 | 2 | 1 | 38.0 | 28.6 | 14.3 | 25.7 | 37.5 |
| 1999 | 7 | 2 | 0 | 0 | 4.0 | 0.0 | 0.0 | 1.2 | 31.0 |
| 1999 | 8 | 2 | 0 | 2 | 4.0 | 0.0 | 28.6 | 12.3 | 37.0 |
| 1999 | 9 | 5 | 0 | 0 | 10.0 | 0.0 | 0.0 | 2.9 | 31.4 |
| 1999 | 10 | 12 | 0 | 0 | 24.0 | 0.0 | 0.0 | 7.0 | 30.9 |
| 1999 | 11 | 3 | 0 | 0 | 6.0 | 0.0 | 0.0 | 1.7 | 24.4 |
| 1999 | 12 | 5 | 0 | 0 | 10.0 | 0.0 | 0.0 | 2.9 | 15.7 |
| 2000 | 1 | 2 | 0 | 0 | 4.0 | 0.0 | 0.0 | 1.2 | 13.4 |
| 2000 | 2 | 7 | 0 | 0 | 14.0 | 0.0 | 0.0 | 4.1 | 11.5 |
| 2000 | 3 | 34 | 0 | 3 | 68.0 | 0.0 | 42.9 | 36.4 | 44.9 |
| 2000 | 4 | 9 | 0 | 2 | 18.0 | 0.0 | 28.6 | 16.4 | 50.5 |
| 2000 | 5 | 5 | 0 | 0 | 10.0 | 0.0 | 0.0 | 2.9 | 42.8 |
| 2000 | 6 | 1 | 0 | 0 | 2.0 | 0.0 | 0.0 | 0.6 | 34.1 |
| 2000 | 7 | 5 | 0 | 2 | 10.0 | 0.0 | 28.6 | 14.0 | 41.0 |
| 2000 | 8 | 4 | 0 | 0 | 8.0 | 0.0 | 0.0 | 2.3 | 34.1 |
| 2000 | 9 | 3 | 0 | 0 | 6.0 | 0.0 | 0.0 | 1.7 | 19.4 |
| 2000 | 10 | 1 | 0 | 1 | 2.0 | 0.0 | 14.3 | 6.2 | 17.4 |
| 2000 | 11 | 7 | 0 | 0 | 14.0 | 0.0 | 0.0 | 4.1 | 17.2 |
| 2000 | 12 | 4 | 0 | 1 | 8.0 | 0.0 | 14.3 | 7.9 | 21.5 |
| 2001 | 1 | 4 | 0 | 0 | 8.0 | 0.0 | 0.0 | 2.3 | 15.9 |
| 2001 | 2 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 12.1 |
| 2001 | 3 | 11 | 0 | 0 | 22.0 | 0.0 | 0.0 | 6.4 | 15.6 |

NR: Newspaper & Newswires, TR: TV & Radio, MZ: Magazines, MI: Media Index

| Year | Month | Raw Score(X) NW | TR | MZ | Standardized Score (Z) NW | TR | MZ | Media Index(S) | Discounted Media Index (T) |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 4 | 16 | 0 | 1 | 32.0 | 0.0 | 14.3 | 14.9 | 25.7 |
| 2001 | 5 | 9 | 3 | 0 | 18.0 | 42.9 | 0.0 | 18.9 | 38.4 |
| 2001 | 6 | 11 | 0 | 1 | 22.0 | 0.0 | 14.3 | 12.0 | 40.6 |
| 2001 | 7 | 24 | 0 | 0 | 48.0 | 0.0 | 0.0 | 13.9 | 45.8 |
| 2001 | 8 | 28 | 0 | 1 | 56.0 | 0.0 | 14.3 | 21.8 | 58.5 |
| 2001 | 9 | 15 | 0 | 0 | 30.0 | 0.0 | 0.0 | 8.7 | 53.8 |
| 2001 | 10 | 11 | 0 | 1 | 22.0 | 0.0 | 14.3 | 12.0 | 51.1 |
| 2001 | 11 | 0 | 0 | 1 | 0.0 | 0.0 | 14.3 | 5.6 | 41.5 |
| 2001 | 12 | 1 | 0 | 0 | 2.0 | 0.0 | 0.0 | 0.6 | 30.6 |
| 2002 | 1 | 30 | 0 | 0 | 60.0 | 0.0 | 0.0 | 17.4 | 38.3 |
| 2002 | 2 | 9 | 0 | 0 | 18.0 | 0.0 | 0.0 | 5.2 | 30.1 |
| 2002 | 3 | 35 | 0 | 2 | 70.0 | 0.0 | 28.6 | 31.4 | 53.3 |
| 2002 | 4 | 16 | 0 | 0 | 32.0 | 0.0 | 0.0 | 9.3 | 48.7 |
| 2002 | 5 | 11 | 0 | 1 | 22.0 | 0.0 | 14.3 | 12.0 | 49.5 |
| 2002 | 6 | 10 | 0 | 0 | 20.0 | 0.0 | 0.0 | 5.8 | 45.2 |
| 2002 | 7 | 8 | 0 | 1 | 16.0 | 0.0 | 14.3 | 10.2 | 41.8 |
| 2002 | 8 | 11 | 0 | 2 | 22.0 | 0.0 | 28.6 | 17.5 | 49.6 |
| 2002 | 9 | 14 | 1 | 2 | 28.0 | 14.3 | 28.6 | 23.8 | 55.3 |
| 2002 | 10 | 19 | 0 | 3 | 38.0 | 0.0 | 42.9 | 27.7 | 69.5 |
| 2002 | 11 | 13 | 0 | 1 | 26.0 | 0.0 | 14.3 | 13.1 | 65.6 |
| 2002 | 12 | 11 | 0 | 5 | 22.0 | 0.0 | 71.4 | 34.2 | 85.2 |
| 2003 | 1 | 13 | 0 | 1 | 26.0 | 0.0 | 14.3 | 13.1 | 78.6 |
| 2003 | 2 | 4 | 0 | 0 | 8.0 | 0.0 | 0.0 | 2.3 | 60.6 |
| 2003 | 3 | 7 | 0 | 3 | 14.0 | 0.0 | 42.9 | 20.8 | 63.0 |
| 2003 | 4 | 6 | 0 | 1 | 12.0 | 0.0 | 14.3 | 9.1 | 52.2 |
| 2003 | 5 | 11 | 0 | 0 | 22.0 | 0.0 | 0.0 | 6.4 | 44.7 |
| 2003 | 6 | 30 | 0 | 0 | 60.0 | 0.0 | 0.0 | 17.4 | 44.2 |
| 2003 | 7 | 21 | 0 | 1 | 42.0 | 0.0 | 14.3 | 17.8 | 49.7 |
| 2003 | 8 | 9 | 0 | 1 | 18.0 | 0.0 | 14.3 | 10.8 | 49.9 |
| 2003 | 9 | 5 | 1 | 2 | 10.0 | 14.3 | 28.6 | 18.6 | 53.1 |
| 2003 | 10 | 9 | 0 | 0 | 18.0 | 0.0 | 0.0 | 5.2 | 45.3 |
| 2003 | 11 | 30 | 0 | 2 | 60.0 | 0.0 | 28.6 | 28.5 | 63.1 |
| 2003 | 12 | 21 | 1 | 1 | 42.0 | 14.3 | 14.3 | 22.3 | 68.3 |
| 2004 | 1 | 15 | 0 | 3 | 30.0 | 0.0 | 42.9 | 25.4 | 75.4 |
| 2004 | 2 | 13 | 1 | 0 | 26.0 | 14.3 | 0.0 | 12.1 | 69.6 |
| 2004 | 3 | 20 | 1 | 0 | 40.0 | 14.3 | 0.0 | 16.2 | 67.0 |
| 2004 | 4 | 14 | 0 | 0 | 28.0 | 0.0 | 0.0 | 8.1 | 60.3 |
| 2004 | 5 | 14 | 0 | 0 | 28.0 | 0.0 | 0.0 | 8.1 | 48.9 |
| 2004 | 6 | 10 | 0 | 0 | 20.0 | 0.0 | 0.0 | 5.8 | 39.1 |
| 2004 | 7 | 13 | 0 | 0 | 26.0 | 0.0 | 0.0 | 7.5 | 32.1 |
| 2004 | 8 | 9 | 2 | 4 | 18.0 | 28.6 | 57.1 | 36.6 | 59.2 |

NR: Newspaper & Newswires, TR: TV & Radio, MZ: Magazines

| Year | Month | Raw Score(X) NW | TR | MZ | Standardized Score (Z) NW | TR | MZ | Media Index (S) | Discounted Media Index (T) |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 9 | 25 | 0 | 1 | 50.0 | 0.0 | 14.3 | 20.1 | 63.2 |
| 2004 | 10 | 25 | 0 | 2 | 50.0 | 0.0 | 28.6 | 25.6 | 74.1 |
| 2004 | 11 | 25 | 0 | 2 | 50.0 | 0.0 | 28.6 | 25.6 | 82.8 |
| 2004 | 12 | 10 | 0 | 1 | 20.0 | 0.0 | 14.3 | 11.4 | 76.1 |
| 2005 | 1 | 12 | 0 | 1 | 24.0 | 0.0 | 14.3 | 12.5 | 71.4 |
| 2005 | 2 | 15 | 1 | 1 | 30.0 | 14.3 | 14.3 | 18.8 | 66.4 |
| 2005 | 3 | 19 | 0 | 1 | 38.0 | 0.0 | 14.3 | 16.6 | 64.4 |
| 2005 | 4 | 10 | 1 | 2 | 20.0 | 14.3 | 28.6 | 21.5 | 66.3 |
| 2005 | 5 | 25 | 0 | 2 | 50.0 | 0.0 | 28.6 | 25.6 | 72.0 |
| 2005 | 6 | 13 | 0 | 4 | 26.0 | 0.0 | 57.1 | 29.8 | 84.4 |
| 2005 | 7 | 11 | 0 | 3 | 22.0 | 0.0 | 42.9 | 23.1 | 87.4 |
| 2005 | 8 | 12 | 1 | 1 | 24.0 | 14.3 | 14.3 | 17.1 | 82.0 |
| 2005 | 9 | 20 | 0 | 3 | 40.0 | 0.0 | 42.9 | 28.3 | 89.6 |
| 2005 | 10 | 30 | 1 | 2 | 60.0 | 14.3 | 28.6 | 33.1 | 99.2 |
| 2005 | 11 | 16 | 2 | 4 | 32.0 | 28.6 | 57.1 | 40.7 | 113.3 |
| 2005 | 12 | 17 | 0 | 7 | 34.0 | 0.0 | 100.0 | 48.9 | 131.7 |
| 2006 | 1 | 25 | 1 | 3 | 50.0 | 14.3 | 42.9 | 35.8 | 135.1 |
| 2006 | 2 | 16 | 1 | 3 | 32.0 | 14.3 | 42.9 | 30.6 | 134.1 |
| 2006 | 3 | 50 | 1 | 0 | 100.0 | 14.3 | 0.0 | 33.6 | 133.5 |
| 2006 | 4 | 26 | 3 | 3 | 52.0 | 42.9 | 42.9 | 45.5 | 143.6 |
| 2006 | 5 | 20 | 0 | 4 | 40.0 | 0.0 | 57.1 | 33.9 | 138.1 |
| 2006 | 6 | 27 | 0 | 3 | 54.0 | 0.0 | 42.9 | 32.4 | 130.0 |
| 2006 | 7 | 14 | 0 | 1 | 28.0 | 0.0 | 14.3 | 13.7 | 108.3 |
| 2006 | 8 | 33 | 0 | 2 | 66.0 | 0.0 | 28.6 | 30.3 | 108.9 |
| 2006 | 9 | 20 | 0 | 4 | 40.0 | 0.0 | 57.1 | 33.9 | 112.2 |
| 2006 | 10 | 48 | 5 | 3 | 96.0 | 71.4 | 42.9 | 67.4 | 145.3 |
| 2006 | 11 | 34 | 2 | 6 | 68.0 | 28.6 | 85.7 | 62.3 | 169.6 |
| 2006 | 12 | 19 | 4 | 2 | 38.0 | 57.1 | 28.6 | 40.4 | 167.7 |
| 2007 | 1 | 45 | 1 | 3 | 90.0 | 14.3 | 42.9 | 47.4 | 177.9 |
| 2007 | 2 | 46 | 3 | 4 | 92.0 | 42.9 | 57.1 | 62.7 | 197.1 |
| 2007 | 3 | 40 | 1 | 0 | 80.0 | 14.3 | 0.0 | 27.8 | 176.6 |
| 2007 | 4 | 37 | 2 | 0 | 74.0 | 28.6 | 0.0 | 30.6 | 154.2 |
| 2007 | 5 | 38 | 0 | 5 | 76.0 | 0.0 | 71.4 | 49.9 | 156.9 |
| 2007 | 6 | 45 | 0 | 3 | 90.0 | 0.0 | 42.9 | 42.8 | 157.7 |
| 2007 | 7 | 28 | 1 | 5 | 56.0 | 14.3 | 71.4 | 48.7 | 162.4 |
| 2007 | 8 | 30 | 0 | 1 | 60.0 | 0.0 | 14.3 | 23.0 | 136.5 |
| 2007 | 9 | 27 | 0 | 5 | 54.0 | 0.0 | 71.4 | 43.5 | 145.4 |
| 2007 | 10 | 47 | 2 | 7 | 94.0 | 28.6 | 100.0 | 75.4 | 183.7 |
| 2007 | 11 | 43 | 7 | 1 | 86.0 | 100.0 | 14.3 | 62.5 | 196.4 |
| 2007 | 12 | 26 | 1 | 4 | 52.0 | 14.3 | 57.1 | 41.9 | 187.8 |

NR: Newspaper & Newswires, TR: TV & Radio, MZ: Magazines

## Appendix G. Relationships of the Functions

The relationships between the functions are summarized in the diagram below. This diagram is made by the author following the diagram in the book of Deaton and Muellbauer (1980).

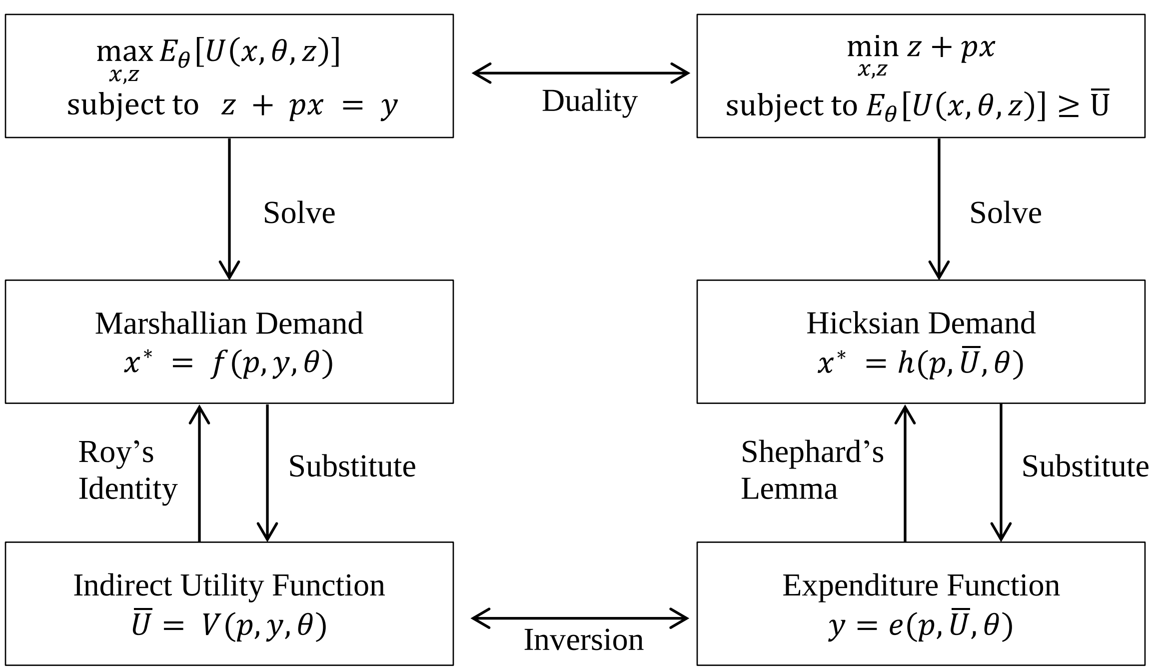
The two problems on the top of this diagram are often described as “dual” problem and these utility maximization and cost minimization imply the same choice.

Shephard’s Lemma:

$$h(p,\overline{U},\theta) = \frac{\partial e(p,\overline{U},\theta)}{\partial p}$$

Roy’s Identity:

$$f(p,y,\theta) = -\frac{\frac{\partial V(p,y,\theta)}{\partial p}}{\frac{\partial V(p,y,\theta)}{\partial y}}$$



## Appendix H. Compensating Variation (CV)

In general, the welfare change is the difference in indirect utility:[88]

$V(p_1, y_1, \theta_1) - V(p_0, y_0, \theta_0)$

To quantify utility changes, however, it is convenient to have monetary measure of changes in consumer welfare. Let the indirect money metric utility function $m(\theta'; p, y, \theta)$ measures how much income the consumer would need at quality distribution $\theta'$ to be as well off as he or she would be facing $p$, $y$, and $\theta$. Then, $m(\theta'; p, y, \theta)$ is defined to be $e(\theta', V(p, y, \theta))$. If we adopt this measure of utility, the above utility difference becomes:

$m(\theta'; p_1, y_1, \theta_1) - m(\theta'; p_0, y_0, \theta_0)$

If we set $\theta'=\theta_0$, the measure is called equivalent variation (EV). If we set $\theta'=\theta_1$, the measure is called compensating variation (CV). Here we use CV.

$$CV = m(\theta_1; p_1, y_1, \theta_1) - m(\theta_1; p_0, y_0, \theta_0)$$

Also,

$m(\theta_0; p_0, y_0, \theta_0) = y_0$ and $m(\theta_1; p_1, y_1, \theta_1) = y_1$

Assuming income does not change, i.e. $y_0=y_1$,

$m(\theta_1; p_1, y_1, \theta_1) = m(\theta_0; p_0, y_0, \theta_0)$

Then,

$$CV = m(\theta_0; p_0, y_0, \theta_0) - m(\theta_1; p_0, y_0, \theta_0)$$

$$= e(\theta_0, V(p_0, y_0, \theta_0)) - e(\theta_1, V(p_0, y_0, \theta_0))$$

Hence[89],

$$CV = e(p_0, \overline{U}_0, \theta_0) - e(p_0, \overline{U}_0, \theta_1)$$

[88] Subscript "1" means "after the change" and subscript "0" means "before the change" for all variables here.
[89] These series of derivations are made by the author, applying the explanation from Varian (1992) to this case.

Appendix I. Illustrations of CV, CpS, COI

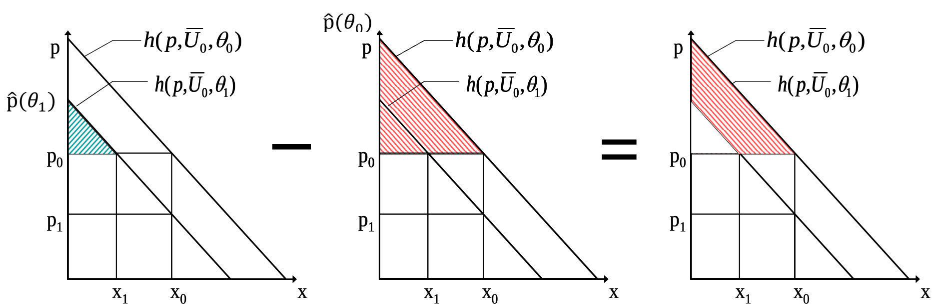
Hicksian demand function is a derivative of the expenditure function (Shephard's Lemma). Following Foster and Just (1989), define $\hat{p}(\theta)$ to be the price where Hicksian demand curve meets the price axis; i.e. $h(\hat{p}, \overline{U}_0, \theta) = 0$.

## I. Compensating Variation (CV)

From (3),

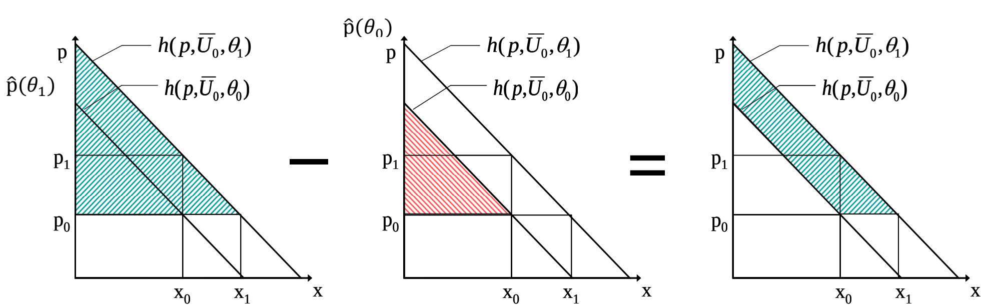
$$
\begin{aligned}
CV &= e(p_0, \overline{U}_0, \theta_0) - e(p_0, \overline{U}_0, \theta_1) \\
&= \{0 - e(p_0, \overline{U}_0, \theta_1)\} - \{0 - e(p_0, \overline{U}_0, \theta_0)\} \\
&= \int_{p_0}^{\hat{p}(\theta_1)} h(p, \overline{U}_0, \theta_1)dp - \int_{p_0}^{\hat{p}(\theta_0)} h(p, \overline{U}_0, \theta_0)dp
\end{aligned}
$$

Case (i): Degradation ($\theta_1 < \theta_0$)




First term Second term CV (-)

Case (ii): Improvement ($\theta_1 > \theta_0$)




First term Second term CV (+)

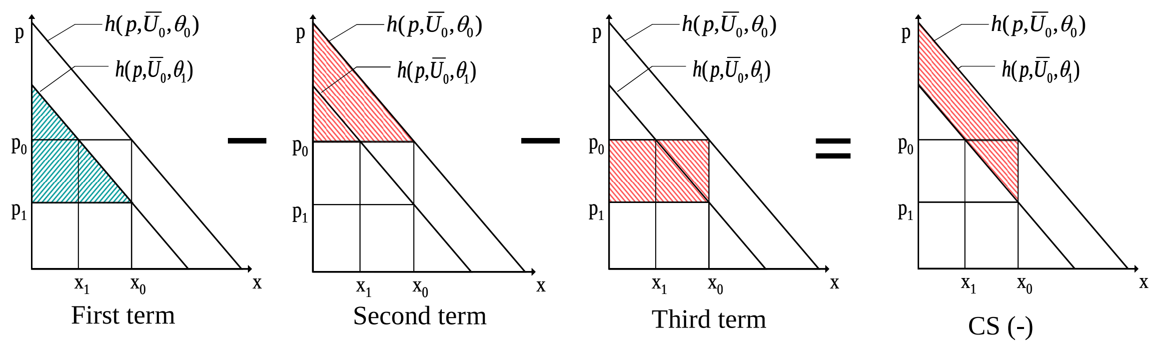
## II. Compensating Surplus (CpS)

From (4'),

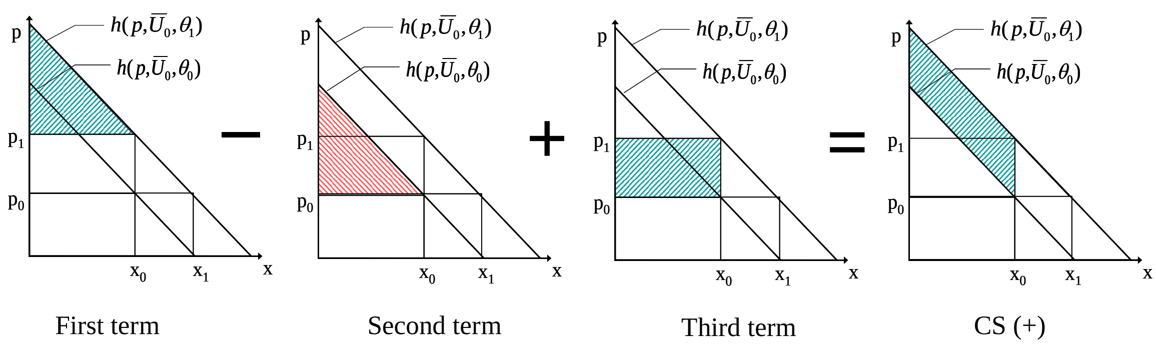
$$CpS = e(p_0, \overline{U}_0, \theta_0) - e(p_1, \overline{U}_0, \theta_1) - (p_0 - p_1)x_0$$

$$= \int_{p_1}^{\hat{p}(\theta_1)} h(p, \overline{U}_0, \theta_1)dp - \int_{p_0}^{\hat{p}(\theta_0)} h(p, \overline{U}_0, \theta_0)dp - (p_0 - p_1)x_0$$

Case (i): Degradation ($\theta_1 < \theta_0$)




Case (ii): Improvement ($\theta_1 > \theta_0$)



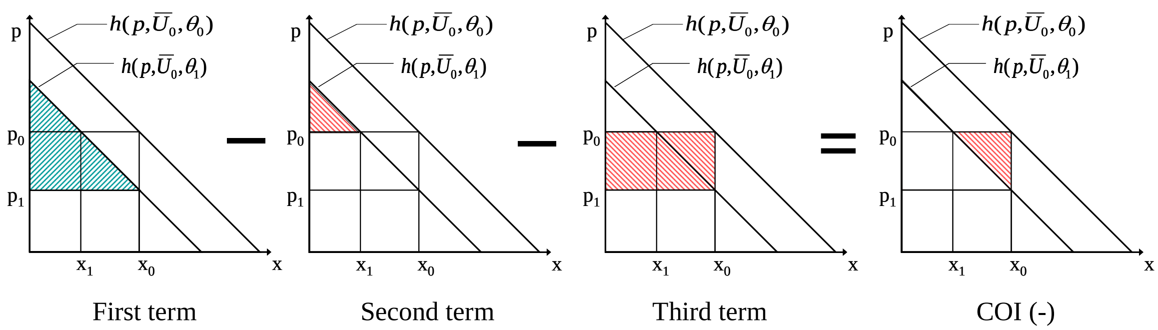
## III. Cost of Ignorance (COI)

From (5'),

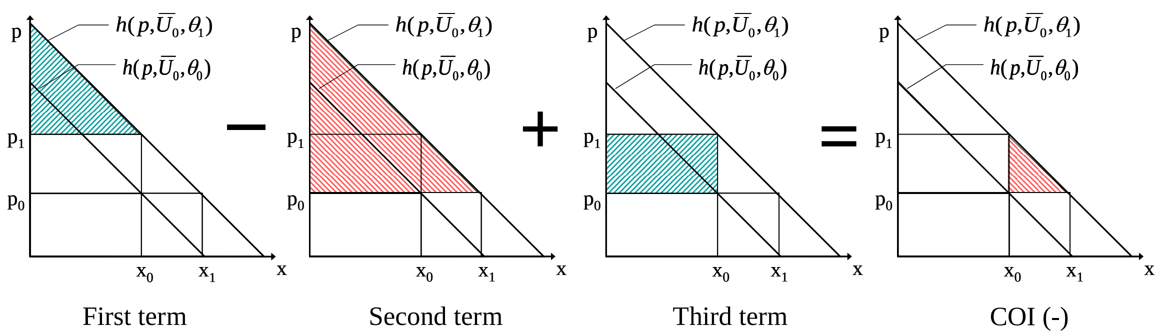
$$COI = e(p_0, \overline{U}_0, \theta_1) - (p_0 - p_1)x_0 - e(p_1, \overline{U}_0, \theta_1)$$

$$= \int_{p_1}^{\hat{p}(\theta_1)} h(p, \overline{U}_0, \theta_1)dp - \int_{p_0}^{\hat{p}(\theta_1)} h(p, \overline{U}_0, \theta_1)dp - (p_0 - p_1)x_0$$

Case (i): Degradation ($\theta_1 < \theta_0$)




Case (ii): Improvement ($\theta_1 > \theta_0$)




The COI derived from (5') is the same as the COI derived by subtracting CV from CpS for either case.