APPLICATIONS OF DEMAND ANALYSIS

FOR THE DAIRY INDUSTRY

USING HOUSEHOLD LEVEL SCANNER DATA

A Dissertation

by

MATTHEW C. STOCKTON

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

DOCTOR OF PHILOSOPHY

December 2004

Major Subject: Agricultural Economics

APPLICATIONS OF DEMAND ANALYSIS

FOR THE DAIRY INDUSTRY

USING HOUSEHOLD LEVEL SCANNER DATA

A Dissertation

by

MATTHEW C. STOCKTON

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

DOCTOR OF PHILOSOPHY

Approved as to style and content by:

Oral Capps, Jr. (Chair of Committee)	John Siebert (Member)
George Davis (Member)	Robert Schwart (Member)
Clair Nixon (Member)	A. Gene Nelson (Head of Department)

December 2004

Major Subject: Agricultural Economics

ABSTRACT

Applications of Demand Analysis for the Dairy Industry Using Household Level Scanner Data. (December 2004)

Matthew C. Stockton, B.S., California State University Fresno; M. S., Texas A&M University

Chair of Advisory Committee: Dr. Oral Capps, Jr.

This study illustrates the use of ACNielsen Homescan Panel (HSD) in three separate demand analyses of dairy products: (1) the effect of using cross-sectional data in a New Empirical Industrial Organization (NEIO) study of ice cream firm mergers in San Antonio; (2) the estimation of hedonic price models for fluid milk by quart, half-gallon and gallon container sizes; (3) the estimation of a demand system including white milk, flavored milk, carbonated soft drinks, bottled water, and fruit juice by various container sizes.

In the NEIO study a standard LA/AIDS demand system was used to estimate elasticities evaluating seven simulated mergers of ice cream manufactures in San Antonio in 1999. Unlike previously published NEIO work, it is the first to use cross-sectional data to address the issue associated with inventory effects. Using the method developed by Capps, Church and Love, none of the simulated price effects associated with the mergers was statistically different from zero at the 5% confidence level.

In 1995 Nerlove proposed a quantity-dependent hedonic model as a viable alternative to the conventional price-dependent hedonic model as a means to ascertain

consumer willingness to pay for the characteristics of a given good. We revisited Nerlove's work validating his model using transactional data indigenous to the HSD. Hedonic models, both price-dependent and quantity-dependent, were estimated for the characteristics of fat content, container type, and brand designation for the container sizes of gallon, half-gallon, and quart. A rigorous explanation of the interpretation between the estimates derived from the two hedonic models was discussed.

Using the Almost Ideal Demand System (AIDS), a matrix of own-price, cross-price, and expenditure elasticities was estimated involving various container sizes of white milk, flavored milk, carbonated soft drinks, bottled water, and fruit juices, using a cross-section of the 1999 HSD. We described price imputations and the handling of censored observations to develop the respective elasticities. These elasticities provided information about intra-product relationships (same product but different sizes), intra-size relationships (different products same container size), and inter-product relationships (different products and different sizes). This container size issue is unique in the extant literature associated with non-alcoholic beverage industry.

DEDICATION

I would like to dedicate the hard work and effort that this dissertation required to my Father and Mother who taught me all the important lessons in life, to my wife Robbie Jean who was and is the wind beneath my wings, as well as the person who is forever taking up all the slack so I could go to graduate school, and to my five sons who never complained when dad was always at work.

ACKNOWLEDGEMENTS

I would like to acknowledge the fine mentors and contributors to my education and to the completion of the Ph.D. degree and dissertation. I would first recognize Oral "Jug" Capps, Jr. for his kindness, patience and never-ending support of both my personal welfare and my scholastic development. There is no finer example of a great coach and a true friend.

I express my sincere appreciation to the following:

George Davis for his many thoughts insights and never ending enthusiasm for completeness and accuracy,

John Siebert for his ever-positive comments and encouragement and down to earth input,

Robert Schwart for his comments and common sense, and all those helpful sessions,

Clair Nixon, who has always been a true friend and who always offered words of encouragement,

Alan Love for standing in for John Siebert when he had to be gone,

David Bessler who although not officially on my committee, has spent a great deal of his time to nurture and guide my economic training, and to

Vicki Heard who spent many hours working on the manuscript to help improve its quality.

TABLE OF CONTENTS

LIST OF TABLES

Page

Page

LIST OF FIGURES

Page

CHAPTER I

INTRODUCTION: OVERVIEW AND ORGANIZATION OF THE DISSERTATION

Introduction

Over the past several decades with the introduction and explosion of computer technology and the advent and growth of scanner recorded information (Nayga), the opportunities for research in the food demand area have expanded. With the ever-escalating cost of data there comes the ever-increasing need to capture as much information as possible concisely and comprehensively from a single source of data. This research focuses on using the same data set of consumer information to answer several different economic questions.

Home scan data are touted by one of its collectors, ACNielsen, as "the leading and premier provider of household purchase and demographic information on consumer trends". Capps and Love in their 2002 *AJAE* article on demand analysis indicated, "scanner data from retailers enhances analysts' ability to understand consumer demand, particularly food products". The most important goal of this work is to answer economic questions and to derive further information on market and consumer behavior through

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

the use of the ACNielsen Home Scan Data (HSD). Three different types of analyses will be completed using this single data source. Each of the applications captures and uses the consumer information provided by HSD to answer three very different economic questions.

The first application is a demonstration of using New Empirical Industrial Organization (NEIO) methodology using cross-sectional data. This demonstration is accomplished by estimating the elasticities from a single commodity demand system of ice cream brands for a single city, and then using those elasticities in a series of simulated mergers to determine their effect on price. The second application focuses on hedonic models. The hedonic process allows for the identification and valuation of product characteristics. An understanding of product characteristic valuation is a step toward understanding the interaction of the consumer with a specific product market. The third and final application is an expansion of the product characteristic valuation. The specific product characteristic studied in this case is container sizes. What are specifically studied are the interactive price relationships that occur between milk and various substitutes, with the inclusion of varying container sizes for both fluid milk and competing beverages, at the household level on an annual basis.

By pursuing these three general themes, several outcomes come to fruition. These outcomes are the expansion of knowledge about the role container sizes play in the beverage market, the specific value of beverage milk characteristics such as fat level, container type, and brand type relative to specific container sizes, and an extension of NEIO applications using a cross-sectional data set.

Background

Cross-sectional data are theoretically more consistent with anti-trust analysis than time-series data, and yet no study in the NEIO literature exists that uses cross-sectional data. Having identified the absence of cross-sectional data from the literature, this work remedies that by using HSD data. The fact that no one has applied HSD data to NEIO work is surprising, considering the richness of the HSD data. Hosken et al., who suggest that cross-sectional data might be more appropriate given the nature of the interpretation associated with such data, further support this gap in the literature. The evaluation of brand merger decisions, by simulation, is one of the extensions and expansions of the HSD data set.

Hedonic models are used to determine the value consumers place on specific characteristics of a good. Many different applications of hedonic models have been done on many different products. However there are no known models that explicitly quantify fat type, brand type and container type for different container sizes of milk. By building such models, information about the valuation of this characteristic becomes evident, further adding to the pool of knowledge about consumers and current consumption patterns.

Fluid milk and processed milk products have been intensely studied both from supply and demand perspectives. One of the few questions, which have yet to be explored in the milk demand literature, is the question about the role different container sizes have on the demand for milk and competing products. Milk and many of the products which are considered to be substitute products, are sold in different container sizes. Milk generally comes in container sizes of gallons, half-gallons, quart, pints and half pints. Carbonated soft drinks (CSD's) are typically sold in cans, generally holding twelve ounces, or in plastic bottles holding one, two, or three liters. Other drinks, such as bottled water and juices, also are sold in various sizes of containers. Since consumers have the option to not only choose the content of the beverage but also the container size of that beverage, it is logical to hypothesize that different container size have an effect on purchase decisions. One of the ways to look at the effect of these varied sizes of containers is to treat them as separate and unique commodities in a demand system.

Data Source

Scanner data have been available from grocery stores since the mid 1970's. The first published academic research using scanner data appeared in 1987 according to the electronic index Econlit (Lattin and Bucklin). The two primary suppliers of scanner data for food products in the U.S., aside from proprietary sources, are Information Resources Incorporated (IRI) and ACNielsen (Bucklin and Gupta). Scanner data for grocery products have many different forms. The most common forms of scanner data are either as a time-series, usually by week for stores doing over two million dollars of business annually, or as a panel of households for all grocery purchases scanned at home for a designated period of time such as a year. (Bucklin and Gupta) An exception to this format is the Kinoshita et al. study of the Japanese milk market, which used daily data.

In 2002, the USDA purchased the 1999 ACNielsen home scan data (HSD), a panel-type of scanner data, to be used in several cooperative agreement projects. One of the reasons these data were purchased was to determine if this type of scanner data could be used as a viable alternative to other data sources, such as survey panels or consumer diaries. Through membership in one of the cooperative teams, these data became accessible for the milk studies that make-up this dissertation.

As a matter of clarification and as a review, the order and format of the research performed is reiterated. Three studies are concluded. The first study is an application of NEIO techniques, where plausible effects of mergers on prices were simulated for ice cream in the city of San Antonio. The second study concerns the estimation of hedonic models of characteristics associated with fluid milk products for three different container sizes. The third and final study is a demand analysis, focusing on container-size, to estimate own-price, cross-price and expenditure elasticities among for white milk and potentially competing beverages, namely bottled water, flavored milk, juices, and carbonated soft drinks.

Organization of the Dissertation

The dissertation is organized as follows. The current chapter, Chapter I serves as an introduction, and as an overview. Chapter II discusses the general nature of the HSD data set, describes the raw format and parts of the data that are relevant to the work done in this dissertation. Chapters III, IV, and V are diverse and therefore have been written as self-contained papers embodying a literature review, a data construction section, and a methodology section. The concluding chapter, Chapter VI, provides a general discussion and concluding remarks with respect to the overall work.

CHAPTER II

THE 1999 ACNIELSEN HOME SCANNER DATA SET

Data Description

Scanner data have been available from grocery stores since the mid 1970's. The first published academic research to appear using store-collected scanner data appeared in 1987. Scanner data has many different forms. The two primary suppliers in U.S. for scanner data are, aside from proprietary sources, Information Resources Incorporated (IRI) and ACNielsen (Bucklin and Gupta). Scanner data have several different forms. Daily information, as used by Kinoshita et al., in their study of the Japanese milk market, is not often used. Weekly scanner data, the most commonly used frequency, is generally a time-series data set (Bucklin and Gupta). The home scan type of data, which is a survey of household purchases for a specified period, generally a year, is another type of scanner data, although found less frequently in the literature. The type of data used in this work is of the home scan type as collected by ACNielsen. The extended studies were described earlier in Chapter I.

The 1999 Nielsen home scan data are unique in that this data set is similar to a survey. Each panelist was supplied with a scanner device that he/she used at home to record items purchased at the grocery store, or other types of stores throughout a given time period. Each panelist represents a unique household, with each household having eighteen known demographic characteristics. A complete list of the demographics variables can be reviewed in Table 1.

Table 1. Demographic Information Available on Households

	Demographic Information	Number of categories
	Panelist ID Number	
1	Household Size	9
2	Household Income	16
3	Age of Female Head	10
4	Age of Male Head	10
5	Age and Presence of Children	8
6	Male Head Employment	5
7	Female Head Employment	5
8	Male Head Education	7
9	Female Head Education	7
10	Martial Status	5
11	Male Head Occupation	12
12	Female Head Occupation	12
13	Household Composition	8
14	Race	4
15	Hispanic Origin	2
16	Region	4
17	Scantrack Market Identifier	53
18	Projection Factor	1

The households are representative of 52 different cities (84.34%) and unidentified rural areas (15.66%) spread over four regions of the lower 48 states of the U. S., northeast, southeast, central, and west. Table 2 shows the regions and Table 3 exhibits a list of the represented cities.

Table 2. Percent of Households by Region

Region	Percent
East	20.3
West	20.0
South	34.3
Central	25.3

The scanner information was collected by date of purchase and included only those panelist that purchased some kind of grocery product in ten out of the twelve-month periods, making a total of 7,195 participating households. The overall data set was divided into four product groupings,

(1) Dry grocery (4,111,719 records),

(2) Dairy (873,899 records),

(3) Frozen (1,002,851 records), and

(4) Random weights (507,306 records),

with each grouping having numerous product modules. Each product module was further subdivided into, brand, size, flavor, form, formula, container, style, type and variety with each one represented each by a unique UPC number.

Table 3. Locations of Households

	City	Percent of Households		City	Percent of Households
1	Rural	15.66	28	San Diego	0.61
2	Boston	1.3	29	St.	0.96
3	Chicago	10.46	30	Tampa	0.77
4	Houston	0.56	31	Baltimore	4.3
5	Indianapolis	1.27	32	Birmingham	0.25
6	Jacksonville	0.28	33	Buffalo - Rochester	1.04
7	Kansas City	0.76	34	Hartford- New Haven	1.17
8	Los Angeles	11.26	35	Little Rock	0.15
9	Suburban New York	5.47	36	Memphis	0.08
10	Urban New York	3.81	37	New Orleans - Mobile	0.18
11	Ex-Urban New York	2.79	38	Oklahoma City - Tulsa	0.13
12	Orlando	0.48	39	Phoenix	1.83
13	San Francisco	0.64	40	Raleigh - Durham	0.23
14	Seattle	0.71	41	Salt Lake City	1.57
15	Atlanta	13.79	42	Columbus	0.58
16	Cincinnati	0.94	43	Washington, D. C.	8.83
17	Cleveland	1.01	44	Albany	0.49
18	Dallas	0.4	45	Charlotte	0.56
19	Denver	0.86	46	Des Moines	0.49
20	Detroit	1.32	47	Grand Rapids	0.91
21	Miami	0.64	48	Louisville	0.18
22	Milwaukee	0.63	49	Omaha	0.56
23	Minneapolis	0.56	50	Richmond	0.28
24	Nashville	0.16	51	Sacramento	0.48
25	Philadelphia	1.8	52	San Antonio	7.51
26	Pittsburgh	1.43	53	Syracuse	1.45
27	Portland, Oregon	1.09			

For example, in a sub-group such as dairy a product module is Cheese – Natural – American Cheddar, module number 3550. An overall summary of the number of modules in each product grouping is given in Table 4.

Table 4. Modules Per Grouping

Product Grouping	Number of Modules
Dry Grocery	417
Dairy	43
Frozen	43
Random Weights	119

In addition to demographic information total expenditure and quantity information were also recorded for each transaction. This information enabled the imputation of price per unit by transaction, depending on the specified units.

Data Selection Process

The data selection process includes all of the steps that are necessary to clean and organize the data in such away so that it was usable for each specific analytical and descriptive purpose.

The first step in the process of obtaining a usable data set was to determine which modules were needed to construct the appropriate data set to be used in the analysis. Of the many hundreds of modules, twenty-one modules from three of the groupings were selected and used in the modeling procedures. Fourteen modules from the dry grocery grouping, four from the dairy grouping, and the three from the frozen food grouping were used. A complete listing of each individual module and its grouping can be seen in Table 5. These raw data were extracted from the original groupings, along with all the appropriate demographic information using SAS.

The information extracted using SAS is different for each of the three studies, since each study requires a different data set. A detailed description of the formulation of each data set is found in the appropriate chapter relative to the specific data set. It should be noted that there are other modules that contain juices, however these are not in the ready to serve form, i.e. frozen juice concentrates or powdered drink mixes.

Table 5. Modules Used To Create Data Sets

Sub-Group / Grouping	Module Number	Product Name
Dry Grocery	1030	Fruit Drinks/Cranberry
Dry Grocery	1031	Cider
Dry Grocery	1032	Grapefruit Juice
Dry Grocery	1033	Apple Juice
Dry Grocery	1034	Grape Juice
Dry Grocery	1035	Grapefruit Juice - Canned
Dry Grocery	1036	Orange Juice - Canned
Dry Grocery	1036	Lemon/Lime Juice
Dry Grocery	1038	Pineapple Juice
Dry Grocery	1039	Prune Juice
Dry Grocery	1040	Orange Juice
Dry Grocery	1041	Fruit Drinks - Canned
Dry Grocery	1042	Fruit Drinks
Dry Grocery	1044	Fruit Drinks Remaining
Dry Grocery	1045	Fruit Juice Nectars
Dry Grocery	1054	Vegetable Juice - Tomato
Dry Grocery	1484	Soft Drinks - Carbonated
Dry Grocery	1487	Water - Bottled
Dry Grocery	1553	Soft Drinks - Low Calorie
Dairy Food	3592	Flavored Milk
Dairy Food	3625	White Milk
Dairy Food	3626	Buttermilk
Dairy Food	3627	Cream
Frozen Food	2671	Frozen Yogurt
Frozen Food	2672	Ice Cream
Frozen Food	2673	Ice Milk and Sherbet

CHAPTER III

USE OF CROSS-SECTIONAL DATA IN NEIO ANALYSIS: AN ILLUSTRATION CONCERNING BILATERAL MERGERS OF ICE CREAM MANUFACTURERS IN THE CITY OF SAN ANTONIO

Introduction

Economics plays an important role in determining the outcome whenever an antitrust issue is considered. One of the ways economics is used to evaluate antitrust issues is through demand analysis and merger simulation. The primary ingredients in horizontal merger simulations are own-price and cross-price elasticities. Since the elasticities are measures of price and quantity relationships, it is important that they reflect the true nature of that relationship.

Past research and discussion in the economic literature has shown that elasticity estimates are affected by the time interval of the data. Capps and Nayga state that, "elasticity estimates based on shorter time periods usually differ from those based on longer time periods". They further indicate the conditions under which shorter-term elasticities are likely to be larger in magnitude than longer-term elasticities. The difference between shorter term and longer-term elasticities is attributed to two actions taken by consumers:

- Storage activity (inventory effect) and
- Product substitution.

The storage effect exists when consumers have inventories on hand, so that when prices rise, buying is discontinued while consumption continues. Substitution occurs when a price increase in one product causes consumers to choose an alternate product to replace the relatively more expensive product.

Given the theoretical difference in elasticity estimates between the data types, it is surprising that so many of the studies used to determine price changes as a result of bilateral mergers use time-series information. Interestingly the literature recognizes this deficit, (Hosken et al.) but, to date, no single study has employed cross-sectional data in a single application. The use of elasticity estimates to determine price changes in industrial organization falls under the guise of New Empirical Industrial Organization (NEIO).

As previously stated, methods of applying demand systems in NEIO are primarily confined to time-series data, usually at the regional level (Hosken, et al). Most of the studies come from Weekly Scanner Data (WSD) similar to that provided by IRI and ACNielsen. Hosken et al. indicated scanner data available from, “IRI and Nielsen are the best to study the demand for these products”. Even with this emphasis on scanner data, there is no mention of household scanner data or HSD data. HSD data are potentially valuable in determining elasticities used in a NEIO analysis. The HSD data, unlike WSD data, are a panel data set containing information by household over time. HSD data treated properly can be used to form a cross-sectional data set which, theoretically, provides a basis for eliminating inventory effects present in estimating elasticities using time-series data. This fact makes HSD a potentially valuable and viable data source for NEIO analysis.

The proper treatment of HSD data requires aggregating the original panel type data across households to create a cross-sectional data set that makes it possible to obtain elasticities measured across households and to avoid possible effects due to storage.

A NEIO study using elasticities produced from a demand system using cross-sectional data is generally considered to produce longer-run elasticities (Kuh and Meyer). When compared to demand system elasticities from time-series data, the cross-sectional demand system provides elasticity estimates that are of a more long-term nature. Long-term price changes are more consistent with antitrust policy, since antitrust concepts are concerned with long term or permanent price increases. Given that antitrust policy is based on the premise of long-term alterations in the market place, the implication is that cross-sectional data may be more appropriate than time-series data for antitrust analysis.

During the 1990s a flurry of mergers, acquisitions and proposed mergers in the frozen dessert and ice cream industry took place. Proposed merger activity is both costly and time consuming to society and to the involved institutions (Mann). Not only does the firm's decision to merge require careful economic analysis, but federal agencies, particularly the Federal Trade Commission (FTC) and the Department of Justice (DOJ), also must do some analyses. Since antitrust issues are mainly a concern within limited geographical areas, analysis is usually done on a regional level. The HSD data are ideally suited to these types of analyses. The HSD have both geographical and product brand information in sufficient detail to make such analysis possible. It is rare to have so much information available in a single data set.

In this chapter we describe the use the unique HSD data to estimate elasticities for seven brands of ice cream of the more than thirty brands of ice cream marketed within the city of San Antonio, Texas in 1999. These elasticities then are used to simulate price changes as the result of mergers. A total of six different possible mergers among the seven different brands of ice cream were considered.

Data

The general description of the ACNielsen HSD, is found in Chapter II of the dissertation. All work in compiling the appropriate subset of data from the ice cream module was done using SAS and Microsoft Excel.

Individual brands and purchases of ice cream are packaged in varying sizes measured in ounces. Converting all purchases to half-gallons allowed all quantity price and expenditures measures to be adjusted to an equal scale, a necessary step for using the LA/AIDS model with the Stone index (Moschini). Since the demand system to be built depends on brands, brands were kept separate. Over thirty brands of ice cream were observed in the San Antonio area in 1999. The more than thirty brands of ice cream were consolidated into seven brands. Five of the brands were individual name brands with the other two brands being combined or composite brands. These seven brands and their market share for 1999 are shown in Table 6. Brands two and seven are composite brands. Brand two is an aggregate of all private label brands, and brand seven corresponds to all remaining name brands. Due to the confidentiality agreement signed with ACNielsen none of the names of the actual brands may be released.

Table 6. Average Budget of Ice Cream by Brand and Brand Aggregation Type

Brands	Average Budget Shares Buy Brand	Single or Composite Brand Type
Brand 1	40.43%	Single
Brand 2	34.85%	Composite
Brand 3	4.44%	Single
Brand 4	4.55%	Single
Brand 5	2.97%	Single
Brand 6	2.58%	Single
Brand 7	10.17%	Composite

Quantity and expenditure information were available as well as any information concerning the use of coupons, special promotions, or price discounts for each transaction. The individual scans or purchases were aggregated by brand for each household. Expenditures and quantities were then totaled for the whole year and divided by annual quantity for each brand, thus providing a mean annual price for each brand by household for the year. Any imputed price more than five standard deviations from the mean would be removed, following Chebychev’s inequality; however, none exceeded this limit.

Four hundred and fifty six households were part of the HSD data set for San Antonio. A brief summary of some of the descriptive statistics about the HSD for ice cream and the demographic profile provide greater understanding of the data quality.

Four hundred and one of the four hundred and fifty six HSD participants in San Antonio purchased at least one brand of ice cream. The average income of the San Antonio participants was approximately $50,700. Households of one person accounted for 18% of the sample, those with two people made up 38%, while those with three people accounted for 19%, households with four or more people made up the remaining 25% of the sample. Households with children under 18 years old made up 31% of the sample, and those with no children this age present comprised about 69%. Households classified by race, were 84% white and 16% all other races. Households were ethnically classified as either Hispanic or not Hispanic, with 18% being Hispanic and 82% not Hispanic.

Since female household heads are considered primary to making food purchase decisions some key statistics about this demographic variable are included. Of all the households 9% did not have a female head of house. Female heads over 65 years old, made up about 13% of the sample, those age 40 years to 65 years old accounted for 32% of the sample, while those female household heads 25 years old to less than 40 years old made up about 26%, and those female heads less than 25 years old accounted for about 20% of the total sample. Education level of the female household heads was divided into those with a high school education or less, 29%, those with more than high school up to a bachelor’s degree, 31%, and those with more than a bachelor’s degree, about 32%. In Table 7, a complete summary of these statistics is exhibited.

Table 7. Selected Demographic Information of San Antonio Households

Description	Amount
Average Income Level	$50,716.00
Race	
White	84%
All Others	16%
Ethnicity	
Hispanic	18%
Not Hispanic	82%
Household Size	
One Person	18%
Two People	38%
Three People	19%
Four or More People	25%
Children Under 18 Years of Age Present in the Household	
Children Present	69%
No Children Present	31%
Age of Female Head of Household	
No Female Head	9%
25 Years Old or Less	20%
26 to 40 Years Old	26%
41 to 65 Years Old	32%
Over 65 Years Old	13%
Employment Status of the Female Household Head	
Unemployed	34%
Works Less than 30 Hours/Week	15%
Works 30 or More Hours/Week	42%
Education Level of the Female Household Head	
High School Education or Less	29%
Some College	31%
A Bachelors Degree or More	32%

In Tables 8 and 9 we highlight the statistics for market penetration and average price. Brand 1, the leading brand, had an average price of $4.33 and a market penetration level of 62.6%. Brand 2, the private label composite brand, had a market penetration of

62.5%. Brand 3 had a market penetration of 9.4% and an average price of $3.56 per half-gallon. Brand 4 has a market penetration of 17.3% and an average price of $3.45 per

Table 8. Market Penetration of Selected Ice Cream Brands for Households in San Antonio

	Number of Households That Bought Ice Cream	Percent of Market Penetration
Brand 1	287	62.90%
Brand 2	285	62.50%
Brand 3	43	9.40%
Brand 4	79	17.30%
Brand 5	40	8.80%
Brand 6	60	13.20%
Brand 7	148	32.50%
All Brands	401	87.90%
No Consumption	55	12.10%
Total	456	100%

Table 9. Statistics for Prices of the Seven Brands of Ice Cream in San Antonio

Brand	Number of Households	Average Price	Standard Deviation	Minimum Observed	Maximum Observed
Brand 1	286	$4.33	$0.91	$1.39	$7.96
Brand 2	285	$2.96	$0.83	$0.65	$5.56
Brand 3	43	$3.56	$0.84	$1.00	$4.49
Brand 4	78	$3.45	$0.71	$1.62	$4.99
Brand 5	40	$11.53	$1.12	$8.94	$13.96
Brand 6	60	$3.67	$0.74	$0.39	$4.99
Brand 7	146	$5.50	$3.51	$1.60	$16.85

half-gallon. Brand 5 had a market penetration of 8.8% and an average price of $11.53 per half-gallon. Brand 6 had a market penetration of 13.2% and an average price of $3.67 per half-gallon. Brand 7, a composite brand, comprised of all other brands, had a market penetration of 32.5% and an average price of $5.50 per half-gallon.

Methodology

Given that elasticity estimates are based on the accuracy of the proposed demand system and representative nature of the collected data, it is important to ensure, as much as possible, that correct estimation techniques are followed.

Several concerns need to be addressed regarding the estimation of the demand system. First, of the many demand systems available to be used which would be the most appropriate? Most of the work done with demand systems and merger simulations traditionally has been done with the LA/AIDS model. Additionally, the data are of a cross-sectional type, so an appropriate model to apply is the LA/AIDS model (Deaton and Muelbauer). The LA/AIDS model is used in this analysis. Equations 3-1 and 3-2 in Figure 1 give the general format of the, Linear Approximation to the Almost Ideal Demand System (LA/AIDS).

Since the data are of a cross-sectional type, the possibility for heteroskedasticity exists. Rather than test for heteroskedasticity directly, two separate models are estimated, one with no corrections made for heteroskedasticity and the other using generalized methods of moments (GMM) correcting for heteroskedasticity. The results of the two models show marked differences in statistical significance of the elasticity estimates indicating the presence of heteroskedasticity. Therefore, the appropriate model used in this analysis is the heteroskedastically corrected model.

(3-1) $? _i = a_i + \sum_j^9 a_{ij} \ln p_j + ß_i(\ln Y - \ln P^*) + \in_i$

Equation 3-1 Mathematical representation of the LA/AIDS model

$w_i =$ budget share of the ith equation, for the ith product.
a_i = the ith equations intercept term.
a_{ij} = the ith coefficient of the jth product.
p_j = price of the jth product.
b_i = the ith coefficient for the expenditure composite variable.
Y = total expenditure.
$\in_i$ = unexp lained part of the model

(3-2) $P^* = \sum_k w_k \ln p_k$

Equation 3-2 The Stone Index approximation portion of the LA/AIDS model

$?_k =$ budget share of the kth product.
p_k = price of the kth product.

Figure 1. The LA/AIDS model specification

The final issue is the censored nature of the data set. Two types of censoring are prevalent in this data. One censoring issue is the fact that households generally purchase a limited number of brands of ice cream. In the case of a household not purchasing a specific brand of ice cream, there is no price recorded for that brand. This situation leaves many missing prices for those brands unpurchased by the different households. A second censoring problem relates to households that did not consume any ice cream at all and, therefore, not only have no prices been recorded but also there are no budget shares for any of the ice cream brands.

Initially the Shonkwiler and Yen consistent two-step (CTS) procedure, a censoring correction method, was used to correct for the households with zero budget shares. However, the resulting elasticity estimates from this procedure were unbelievably large. These large elasticities are possibly a result of the small budget shares and limited market penetrations for several of the brands.

In the case of several households where no ice cream was purchased and, therefore, had no budget shares for all brands of ice cream, these households were not used in the estimation process. The complete absence of consumption might have been addressed using a three-step method introduced by Asatryan, but considering the problems encountered in the two-step method the use of this technique was not attempted.

Regardless of the censoring problem, imputations for the missing prices, the right- hand-side (RHS) variables, needed to be made in order to estimate the demand system. Information was available to make these imputations. One of the advantages of the HSD data is the demographic information available for each household. By regressing observed prices on these demographic profiles, imputations for the missing price values were made. This type of price imputation is known as a first-order imputation. It should be noted that this technique implies that households of similar demographics shop at stores with similar prices, which, considering the limited geographic area, is plausible. Figure 2 gives a complete description of the variables and represents the regression equation, equation (3-3). All of the demographic variables in the regression model except household income are indicator variables. The estimated intercept term corresponds to the base demographic profile. In this case the base profile is that of a white Hispanic household with children under eighteen years of age, with a household size of more than four people, having a female head of house that has some college education, between the ages of twenty-five and forty, and works more than 30 hours a week. Imputation for each price was made using the estimates from the regressions of only those households that purchased that brand of ice cream. The predicted prices then were imputed using the estimated coefficients. The predicted prices were used to fill in any missing values. The estimated beta coefficients and regression statistics from the imputation process can be found in Appendix A.

One of the peculiarities of the LA/AIDS model is that there is several ways to calculate elasticities from the systems estimated coefficients. The Green and Alston 1990 paper discusses the differences between these methods. According to their results their (iii) and (iv) methods are both appropriate methods for calculating uncompensated elasticities. Since method (iii) is mathematically easier to apply than the method (iv), it is the method choice for calculating the uncompensated elasticities.

$$\hat{P}_{ih} = \hat{b}_0 + \hat{b}_{1ih} * (AverageIncome) + \hat{b}_{2ih} * (OnePersonHousehold)$$
$$+ \hat{b}_{3ih} * (TwoPersonHousehold) + \hat{b}_{4ih} * (ThreePersonHousehold) + \hat{b}_{5ih} * (FemaleHead < 25)$$
$$+ \hat{b}_{6ih} * (FemaleHead40to65) + \hat{b}_{7ih} * (FemaleHead > 65) + \hat{b}_{8ih} * (NoChildren)$$
$$+ \hat{b}_{9ih} * (FemaleHeadHighSchoolorless) + \hat{b}_{10ih} * (FemaleHead4orMoreYearsCollege)$$
$$+ \hat{b}_{11ih} * (RaceNotWhite) + \hat{b}_{12ih} * (FemaleHeadUnEmployed)$$
$$+ \hat{b}_{13ih} * (FemaleHeadEmployed < 30hrs) + \hat{b}_{14ih} * (NonHispanicEthnicity)$$

Equation 3-3. Price imputation regression equation.

$\hat{P}_{ih}$ - Where P is the imputed price of the i^{th} product and h^{th} household
$\hat{b}_{0h}$ - The intercept term for the base profile for the i^{th} product of the h^{th} household.
$\hat{b}_{1ih}$ - The effect of average income on the i^{th} product of the h^{th} household.
$\hat{b}_{2ih}$ - The effect of having a one-person household on the i^{th} product of the h^{th} household.
$\hat{b}_{3ih}$ - The effect of having a two people household on the i^{th} product of the h^{th} household.
$\hat{b}_{4ih}$ - The effect of having a two people household on the i^{th} product of the h^{th} household.
$\hat{b}_{5ih}$ - The effect of having a female household head less than 25 years old on the i^{th} price of the h^{th} household.
$\hat{b}_{6ih}$ - The effect of having a female household head between than 40 and 64 years old on the i^{th} price the h^{th} household.
$\hat{b}_{7ih}$ - The effect of having a female household 65 years old or older on the i^{th} price of the h^{th} household.
$\hat{b}_{8ih}$ - The effect of having no children under 18 years old in the household on the i^{th} price of the h^{th} household.
$\hat{b}_{9ih}$ - The effect of having female household head with a high school education or less on the i^{th} price of the h^{th} household
$\hat{b}_{10ih}$ - The effect of having female household head with more than four years of college on the i^{th} price of the h^{th} household.
$\hat{b}_{11ih}$ - The effect of a household with a race other than white on the i^{th} price of the h^{th} household.
$\hat{b}_{12ih}$ - The effect of the female household head having no employment on the i^{th} price of the h^{th} household.
$\hat{b}_{13ih}$ - The effect of the female household head working less than 30 hours a week on the i^{th} price of the h^{th} household.
$\hat{b}_{14ih}$ - The effect of a non-Hispanic household on the i^{th} price of the h^{th} household.

Figure 2. Price imputation variables and regression equation

The elasticities subsequently are used to simulate six hypothetical mergers. The process developed by Capps, Church and Love (CCL method) is used for this simulation. The CCL method is based on three primary assumptions: (1) firms are maximizing profit under the conditions of a Nash equilibrium by choosing price; (2) the notable consequence of these assumptions provides a mathematical means of using the estimated coefficients in formulas representative of merged firms; and (3) these formulas, being a function of the coefficients or primitive estimates, provide the way to obtain the variances, which then provide the means of determining statistical significance.

There are two ways to apply the CCL method. If each brand is uniquely representative of a single firm, the delta method (Fieveson) can be applied to the CCL formula for a bilateral merger. If there are multiple brands per firm a bootstrapping technique must be applied. In this case, the data are of the single-firm type; therefore the duopoly formula using the delta method was applied, as shown in Figure 3.

The power of the CCL method is that it offers not only an estimate of the simulated price change, but also provides the statistical tools to test the price effect of that simulated merger. To better understand the CCL method a brief review of how the delta method works is instructive. To quote Alan H. Feiveson of NASA, “The Delta Method, in its essence, expands a function of a random variable about its mean, usually with a 1-step Taylor approximation, and then takes the variance. For example, if we want to approximate the variance of a function G(X) where X is a random variable with mean μ and G_0 is differentiable," Feiveson then gives this formula.

Percentage Increase in price as a result of a Duopoly Merger $= \dfrac{p_i^m - p_i}{p_i}$

$p_i^m =$ price of the i^th brand as a result of the merger of the i^th and j^th firms.

$p_i =$ price of the i^th brand prior to any mergers.

$$\frac{p_i^m - p_i}{p_i} = \frac{e_{ji}\left(e_{ij} - e_{ii} \frac{w_j}{w_i}\right)}{e_{ii}\left(e_{ji}\left(e_{ij} + \frac{w_j}{w_i}\right) - e_{jj}(1 + e_{ii})\right)} = \mathbf{G}(\boldsymbol{x})$$

where ($\boldsymbol{x}$) is a vector of primal parameters estimated from the LA/AIDS model and average budget shares .

$e_{ii} =$ Own price elasticity of the i^th brand.

$e_{jj} =$ Own price elasticity of the j^th brand.

$e_{ij} =$ Cross price elasticity of the j^th brand price on the i^th brand quantity.

$e_{ji} =$ Cross price elasticity of the i^th brand price on the j^th brand quantity.

$w_j =$ The average budget share of the j^th product.

$w_i =$ The average budget share of the i^th product.

Figure 3. Bertrand duopoly merger equation used in conjunction with the delta method

(3-4) $G(X) = G(\mu) + (X - \mu)G'(\mu)$

Equation 3-4. Delta Equation

which in variance form is

(3-5) $\quad \mathrm{VarG}(X) = \mathrm{Var}(X) * [G'(\mu)]^2$.

Equation 3-5. Variance form of the Delta Equation

Where $G'(\mu)$ is the first derivative of G(X) with respect to X evaluated at μ.

However, in this case we are not dealing with a single variable but rather a vector of variables, but the same procedure holds while applying the rules of matrix algebra. The delta method was applied to the CCL duopoly formula by using the Shazam program test statement after the system estimation. The Shazam program evaluates $G'(\mu)$ and does the necessary calculations to determine the variance of $G'(x)$ and performs a Chi-squared test.

Results of the Demand System Elasticity Estimates

The coefficient estimates and corresponding standard errors for the heteroskedastically corrected LA/AIDS model for the system of seven equations is found in Appendix B. Table 10 is a summary of the uncompensated elasticities estimated for the seven equation LA/AIDS model, and Table 11 is a summary of the compensated elasticity estimates. All the elasticity estimates were calculated using the Green and Alston (1990) type iii formula. In each table the number below each elasticity estimate is the associated p-value representing its statistical significance. All of the italicized values are statistically significant at the five percent level. Only those elasticities that are statistically significant at the five percent level are discussed.

All of the uncompensated own-price elasticities are negative except for brand 6. Three of the seven own-price elasticities are statistically significant, brands 1, 2, and 7. These three brands also have the highest market penetration, brands 2 and 7 are the composite brands and brand 1 is the leading brand. Of the forty-two remaining cross price elasticities, nine are statistically significant.

Table 10. Uncompensated Elasticity Estimates for Brands of Ice Cream in San Antonio

	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	Brand 6	Brand 7
Brand 1	***-1.4289***	***0.4181***	0.0806	***-0.1721***	-0.0005	-0.0106	***0.1773***
p-value	***0.000***	***0.001***	0.067	***0.006***	0.994	0.817	***0.015***
Brand 2	***0.4151***	***-1.6457***	0.0494	0.1134	-0.0067	0.0605	-0.0951
p-value	***0.006***	***0.000***	0.185	0.104	0.892	0.057	0.248
Brand 3	0.6371	0.3648	-1.0011	0.2154	-0.4366	***-1.3425***	0.3892
p-value	0.109	0.210	0.121	0.663	0.274	***0.010***	0.195
Brand 4	***-1.6073***	0.8638	0.2128	-0.6576	0.0534	0.1798	-0.1702
p-value	***0.004***	0.107	0.659	0.562	0.918	0.720	0.528
Brand 5	0.0664	0.0448	-0.6341	0.0985	-0.3292	-0.3849	0.3841
p-value	0.938	0.940	0.285	0.901	0.669	0.576	0.407
Brand 6	-0.1037	***0.9313***	***-2.2950***	0.3323	-0.4443	0.9857	-0.1883
p-value	0.883	***0.033***	***0.010***	0.706	0.574	0.433	0.688
Brand 7	***0.7295***	-0.2443	0.1833	-0.0647	0.1087	-0.0502	***-1.5372***
p-value	***0.013***	0.391	0.167	0.597	0.424	0.674	***0.000***

The nine cross-price elasticities are for brands one/two, brands one/four, brands one/seven, brands three/six, and their reciprocals as well as brands six/two. Of the nine statistically significant cross-price elasticities, eight are significant in four symmetrical pairs. The cross price effect for the brands one/four, four/one, three/six, and six/three were negative, indicating gross complementary relationships. A post merger price decrease results when this method of simulation is used given a complementary relationship.

All of the compensated own-price elasticities are negative except for brand 6, just as is the case for the uncompensated elasticities. Three of the seven own-price elasticities are statistically significant, brand 1, 2, and 7, again the same as in the uncompensated case.

Table 11. Compensated Elasticity Estimates for Brands of Ice Cream in San Antonio

	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	Brand 6	Brand 7
Brand 1	***-1.0504***	***0.7444***	***0.1222***	***-0.1295***	0.0273	0.0136	***0.2725***
p-value	***0.000***	***0.000***	***0.006***	***0.038***	0.675	0.767	***0.000***
Brand 2	***0.8636***	***-1.2591***	***0.0987***	***0.1638***	0.0262	***0.0891***	0.0177
p-value	***0.000***	***0.000***	***0.009***	***0.019***	0.598	***0.005***	0.831
Brand 3	***1.1116***	***0.7739***	-0.9489	0.2688	-0.4017	***-1.3122***	0.5086
p-value	***0.006***	***0.009***	0.142	0.586	0.313	***0.011***	0.094
Brand 4	***-1.1523***	***1.2560***	0.2628	-0.6064	0.0868	0.2088	-0.0557
p-value	***0.038***	***0.019***	0.586	0.592	0.867	0.677	0.838
Brand 5	0.3714	0.3077	-0.6006	0.1328	-0.3068	-0.3654	0.4609
p-value	0.675	0.598	0.313	0.867	0.689	0.594	0.323
Brand 6	0.2125	***1.2039***	***-2.2603***	0.3679	-0.4210	1.0058	-0.1088
p-value	0.767	***0.005***	***0.011***	0.677	0.594	0.423	0.817
Brand 7	***1.0832***	0.0606	0.2222	-0.0249	0.1347	-0.0276	***-1.4482***
p-value	***0.000***	0.831	0.094	0.838	0.323	0.817	***0.000***

Of the forty-two remaining cross price elasticities, sixteen are statistically significant. The sixteen significant cross-price elasticities are for brands one/two, brands one/three, brands one/four, brands one/seven, brands two/three, brands two/four, brands two/six, and brands three/six and their reciprocals. All sixteen statistically significant cross-price elasticities are significant in symmetrical pairs. The cross-price effect for the brands one/four, four/one, three/six and six/three are negative, indicating net complementary relationships. The remaining twelve positive statistically significant elasticities were used as indicators of mergers that might result in significant price changes. Since these twelve cross-price elasticities are reciprocals, only six mergers are required to include all twelve of the price effects.

Results: Simulated Price Changes

The result of the six chosen price simulations are found in Table 12. No merger price change was significantly different from zero.

Table 12. Simulated Merger Results for Brands of Ice Cream In San Antonio

Simulated Merger	Percent Increase in Price
Brand 1 and 2	2.7457
p-value	0.51
Brand 1 and 3	0.3440
p-value	0.37
Brand 1 and 7	0.7909
p-value	0.36
Brand 2 and 3	0.0988
p-value	0.45
Brand 2 and 4	0.8046
p-value	0.77
Brand 2 and 6	-0.1392
p-value	0.28

The largest estimated price increase was between the two largest firms, at 2.7457 %. Economic logic indicates that a change in price would most likely occur for mergers between those firms with largest market shares, which is the case for the brand1 and 2 merger. The negative price change for the brand 2 and 4 merger is due to the positive own-price elasticity for brand 6. All of the other simulated mergers result in a less than 1% price increase. Based on these price changes, it is unlikely the DOJ or FTC would have any objections to any of mergers involving these firms.

Discussion

The use of cross-sectional type data is a viable way of obtaining elasticities that are consistent with the concept of permanent or long-term effects. By using these cross-sectional elasticities in the simulation of unilateral mergers, no mergers were found to be statistically significant. Further investigation and extensions are needed to solidify the outcome of this work. Issues with regard to censoring remain unsolved. A smaller set of brands could be considered, thus increasing market penetration and budget share sizes of the included brands. Other methods of imputing missing prices could be investigated. Other demand system specifications could be applied such as a Indirect Translog, Quadratic AIDS, or the Nonlinear AIDS models. Using these other specifications could help determine the robustness of our results.

However, the key question that remains unanswered is the following: does using cross-sectional data make that much difference in the magnitude of the elasticities?

Without having the a comparable time series it is difficult to determine if the elasticity estimates are a function of the type of data used. The question remains as to the actual effects of inventory and product substitution. Since different food products have different shelf lives, storage requirements, and viable substitutes, it is likely that they also have different inventory and substitution effects. Without closer examination of the individual products, the difference between the short-term and long-term elasticities is yet to be delineated. What is determined by this work is that HSD data are consistent with long-run price changes, making it a viable tool in evaluating mergers and acquisitions.

CHAPTER IV

NERLOVIAN HEDONIC MODELS FOR THREE DIFFERENT CONTAINER SIZES OF FLUID MILK

Introduction

The literature is full of demand studies on fluid milk. Many of these studies use demand systems or single-equation models to derive elasticity estimates for price/quantity relationships, income, and in some cases advertising expenditures. While elasticity measures are invaluable in describing price relationships among goods and in giving economic analysts a description of the inter-workings of a market, they fail to explain the value of the individual components or attributes of a particular good. To understand how consumers value a commodity requires further understanding, such as the identification and valuation of the commodity's components, attributes or characteristics. Hedonic price estimation is the method typically used to estimate the value of the characteristics that make-up a commodity (Waugh).

Given that the study is to be performed on retail scanner data, the assumption that consumers are price takers is consistent with Nerlove's hypothesized polar case two, wherein the dependent variable in the hedonic model are quantities in lieu of prices. In this light a series of quantity dependent hedonic models are used to determine the valuation of the characteristics of white milk for three different container sizes, gallons, half-gallons and quarts. The hedonic models provide information relative to attributes of brand type, container type, and milk fat type for consumers of milk. Knowledge of this type provides information that could allow decision makers to be more precise about adjustments of characteristics and in the development of more comprehensive production, pricing, and advertising strategies.

The dairy industry and companies within the food industry spend millions of dollars annually to promote milk and milk products both generically and proprietarily. It is both logical and timely to consider the effects that the interaction of milk fat type, brand type, and container type, by container size, have on the intrinsic value placed by consumers. This knowledge leads to a better understanding of consumer behavior and make it possible for stakeholders to make better and more informed decisions about production and promotion decisions. However, it should be noted that, to date no one has estimated hedonic models for any of these attributes of white (unflavored) milk.

Literature

By identifying the marginal implicit price that consumers place on attributes, manufacturers would be able to discern the relevant characteristics and the effect these characteristics have on the valuation of their product. However, the method of determining marginal implicit price is complicated by identification problems. This fact has been addressed in the literature and raises some theoretical and econometric challenges, which further motivate the timeliness and need for this analysis.

Depending on the conditions of the price discovery process, close attention to the economic theory and the econometric implementation of that theory becomes paramount to interpretation and implication of the estimated coefficients of the hedonic models. Just as Working showed the simultaneous nature of supply and demand requires close attention to econometric detail to correctly identify demand or supply relationships so, Rosen has shown that hedonic estimation requires similar close attention. It was Nerlove who pushed Rosen's work further and identified two simple cases when estimation was possible without the complication of identification problems.

The first known use of a hedonic type of model was that of Frederic V. Waugh, who first applied it in 1927 to a market study of three different vegetables. Waugh recognized that there was a statistical relationship among characteristics or attributes of the vegetables, i.e. color, stem length etc,. and the prices they brought at auction. Waugh, who had limited computational equipment, estimated what he called coefficient of variation from several regressions equations. Unfortunately for Waugh his application had some econometric discrepancies. However, his main premise has proved to be useful for many different applications. Ernst R. Brendt provides a complete explanation of the econometrics Waugh used in his original papers.

Almost a decade after Waugh's work, Andrew Court, who coined the phase hedonic, applied this same theory to automobile prices to adjust the price index for automobiles in an effort to prevent government intervention in the auto industry (Goodman). But it was not until over twenty years after Court's work that hedonic price models gained real notoriety. It was Zvi Griliches who applied them to indexes in 1961 which was instrumental in pushing this type of model into the toolboxes of economists (Brendt). Griliches was able to grasp the economic significance and power behind the hedonic concept and then demonstrate its practical application. Griliches' applications of the hedonic methods were generally applied to adjusting for changes in characteristics of similar items through time. This concept is very much associated with indices. Through his work, the ever-occurring changes that persist as a result of technology can be adjusted for by hedonic application to indices. This procedure is now commonly applied for both demand and supply work.

Many different applications of the hedonic modeling process are used in many fields of economics. One of the most common uses of hedonics is to recover price information where no explicit market information is available. Hedonics are used in the valuation of resources (Goodman) as well as many others including the valuation of fresh tomato characteristics (Jordan et al.), and many other applications too numerous to list.

Further developments and improvements to the hedonic process have continued to come forth. In his 1974 paper Rosen verifies that the identification problem is not just limited to supply and demand models but extends to hedonic price models. Nerlove, in his 1995 *European Economic Review* article, recognizing the identification problem brought to light by Rosen, identifies two interesting conditions associated with identification. Nerlove follows through on the theoretical underpinnings that are implied by price exogeneity and derives a new method for estimating hedonic price models, quite different from the traditional or Waughian hedonic estimation process. Since

Nerlove’s original work, very few papers have capitalized on the theoretical underpinnings he set forth.

For whatever reason, Nerlove’s main point, the validation of hedonic price estimates as being directly tied to the processes that generate the estimates, has been ignored. It is the intention of this paper to revisit the issue by estimating the hedonic models based on Nerlove’s guidelines and to present those estimates as being appropriate for scanner data. Whereas Nerlove’s data required many assumptions to justify the use of his particular data set, scanner data provided by ACNielsen is retail in nature and requires very few assumptions to implement Nerlove's hedonic methodology.

Detailed Data Description

For a general description of the ACNielsen home scan or HSD data please refer to chapter two. In the original ACNielsen data, there are twenty-one different pieces of information collected for each transaction. Table 13 summarizes the categories of information recorded.

HSD is a panel type data set that is compiled by households overtime and, for ease of access, is grouped by modules. Each module is a general description of the product included in that module. An example of a module is Dairy-Milk – Refrigerated. Products in this module are refrigerated milk in all the different sizes, container types and fat types, etc. Purchases for each household are recorded as they are made.

Table 13. Information Collected in the Home Scanner Data Set

#	Type of Information Collected
1	Household Id
2	Purchase Date (YYMMDD)
3	Product Module
4	Brand
5	Size
6	Multi
7	UPC (Universal Price Code)
8	UPC Description
9	Quantity (Packages)
10	Price Paid Deal
11	Price Paid Non-Deal
12	Coupon Value
13	Flavor
14	Form
15	Formula
16	Container (Type)
17	Salt Content
18	Style
19	Type
20	Product
21	Variety

A household ID number records transactions for each household for the day, month, and year of each individual purchase. A single transaction is comprised of items that are completely homogenous in description and are purchased at the same time by the individual household. The other eighteen categories of information that are recorded in the original data set relate to quantity, cost, or product description for each purchase.

The quantity description includes the size of the unit purchase, which is measured in thousandths of ounces. The word “multi” refers to the number of units per package, and the quantity to the number of bundles or packages.

Cost information comes in three forms. Each of the three forms is in reference to total expenditure or total value per transaction. Price Paid Non-Deal (PPND) refers to a purchase where no coupon or promotional discount is recognized. Price Paid Deal (PPD) is the total expenditure of the transaction recognizing there is a discount, however, the recorded price is not adjusted for the value of the coupon or discount. The PPND has no adjustment for promotion or coupon value and is the actual expenditure for that transaction, while the PPD must have the coupon value subtracted from it before it is the actual transaction expenditure.

Of the remaining twelve descriptive categories, seven contain no information for milk. These categories are flavor, form, formula, salt content, style, variety, and product. The two UPC categories contain the UPC number code for each product and a UPC abbreviated description. The remaining three descriptions are for brand, container type, and content type. The brand describes a product seller or manufacturer and can be either a name brand such as Adhor Farms or a private label brand, such as Albertson’s or some other store brand. The container type has four possibilities, plastic, glass, pouch, and carton. Type is an abbreviated description of the label declaration of fat content.

Hedonic Data Set Creation

Extraction of the data from the original or full data set requires a program that is capable of handling large amounts of information, since the number of total transactions is in the millions. SAS is such a program and is used for the compilation of the data set used for hedonic price analysis. A description follows of each of the variable categories and how they were extracted and modified to form the data set to be used by the econometric package used to build the hedonic price models.

Only the month number portion of the date variable was included in the new data set, resulting in assigning the months consecutive numbers starting with one for January and ending with twelve for December.

Brands are designation as one of two types. Private label brands were given the value of 1, and all other name brands are designated as 0. This new indicator variable is known as label. White milk had a total of three hundred eighty-three brand types consisting of one aggregated private label brand and three hundred eighty-two name brands.

The variable for container type is simply named “cont.”, an abbreviation for container.

The size variable in the original data is converted to ounces and named “ounces”. This is accomplished by dividing the original size variable by one thousand.

Only the three most common sizes of milk purchases, the gallon, half-gallon, and quart are included. It is likely that supermarket purchases of milk will occur in these sizes, whereas other sizes are more likely to be bought in other venues. Aside from these three sizes other odd sizes are observed that range in size from 24 ounces to 127.8 ounces. However, the odd sized containers only occur two hundred nine times out of over two hundred fifty-two thousand occurrences. They account for about .08 percent of all observations (see Table 4-2). Rather than exclude these uncommon container sizes, they are classified to the closest common size. The sizes are coded into a variable known as "jug" with a representation of 1 for the gallon size, 2 for half-gallon, and 3 for quart. A full description of the containers by size, and assignment of odd container sizes are shown in Table 14.

Table 14. Transactions by Container

Ounces	Container Size	Coding	Number of Codings
128	gallon	1	148,590
127.8	gallon	1	16
114	gallon	1	20
101.4	gallon	1	77
Total			**148,703**
88	half-gallon	2	63
72	half-gallon	2	13
64	half-gallon	2	80,847
57	half-gallon	2	5
Total			**80,928**
32	quart	3	26,468
24	quart	3	15
Total			**26,483**
	All Transactions		256,114
	Odd-sized Container		209

The total expenditure per transaction was transformed into a variable identified as “price”, which is derived from the PPND, PPD and the coupon value. The total expenditure for a single transaction is equal to either the PPND or PPD minus the value of the coupon. Remember that a coupon value is only present if there was a deal offered. The actual value or expenditure is then divided by the number of containers purchased per transaction, either as a, quart, half-gallon, or gallon, which gives an imputed price per container, identified as the variable “untprice”.

There are 102 different fat types in the original data set. The original data set contains a brief description of each type of milk sold at the various stores across the U.S.. This abbreviation includes an indication of fat type. All 102 different descriptions are evaluated by physical observation and are assigned according to one of five classifications and coded as 0, 1, 2, 3, or 4 under the new variable known as “fat”. The assignment of the five numbers are as follows, whole milk (approx. 3% or more fat) coded as a 1, reduced fat milk (approx 2% fat) coded as 2, low-fat milk (approx. 1% fat) coded as 3, skim milk (approx. 0% fat) coded as 4, and unclassifiable descriptions as 0.

In addition to the nine products description variables, just discussed, eighteen demographic or household description variables were transferred from the original data set to the hedonic price data set, to be used as control variables in the hedonic estimation.

Description of the Hedonic Data Set

The study of hedonic prices for all fluid white milk required the extraction of each individual transaction from the Dairy-Refrigerated-Milk module (3625), which has a total of 247,913 transactions, but only 243,913 transactions were available for use. The remaining 3202 observations were either excluded for container sizes smaller then a quart, or were unclassifiable for fat types. A summary of the number of dropped transactions and the reason they were excluded is exhibited in Table 15.

Table 15. Dropped Observations

Number of Observations Dropped	Reason Observations was Dropped
513	Unclassifiable fat types.
2663	Smaller then the quart size.
26	Both unclassifiable fat and smaller than quart size.
3202	Total number dropped from the sample.

Module 3625 contains only white milk and is in the Dairy Products group along with forty other dairy product modules. A complete statistical breakdown of average cost by container size and fat type for this module can be seen in Table 16. The highest price paid for a gallon of milk is $9.22 for whole milk while the highest half-gallon price is $4.39 for skim milk. The highest price for a quart of milk is $3.39 for skim milk. The minimum price for all types and container sizes of milk is zero, which indicates that each

Table 16. Statistical Description of Milk by Fat Type and Container Size

Container Size	Number of Transactions	Mean Price in Dollars	Standard Deviation	Minimum Observation in Dollars	Maximum Observation in Dollars
		White Milk			
Gallon	147,464	$2.51	$0.50	$0.00	$9.22
Half-Gallon	75,357	$1.68	$0.46	$0.00	$4.39
Quarts	21,092	$1.11	$0.34	$0.00	$3.39
Total	243,913				
		Whole Milk			
Gallon	28,299	$2.66	$0.49	$0.00	$9.22
Half-Gallon	14,289	$1.67	$0.34	$0.00	$3.99
Quarts	5,418	$1.07	$0.29	$0.00	$1.99
Total	48,006				
		Reduced Fat Milk			
Gallon	55,502	$2.49	$0.50	$0.00	$7.47
Half-Gallon	23,268	$1.64	$0.43	$0.00	$3.99
Quarts	5,958	$1.09	$0.33	$0.00	$3.00
Total	84,728				
		Low-fat Milk			
Gallon	25,782	$2.51	$0.50	$0.00	$5.69
Half-Gallon	13,864	$1.68	$0.46	$0.00	$3.99
Quarts	2,427	$1.13	$0.36	$0.00	$2.49
Total	42,073				
		Skim Milk			
Gallon	37,881	$2.42	$0.50	$0.00	$8.18
Half-Gallon	23,936	$1.73	$0.53	$0.00	$4.39
Quarts	7,289	$1.14	$0.38	$0.00	$3.39
Total	69,106				

type and size was acquired during the year by at least one household for a zero price. This situation is most likely the result of special deals or promotions. An example of such a deal or promotion would be the purchase of two units with a third unit given at no charge.

A description of the percentage of transactions by container size and fat type can be found in Table 17. The reduced fat milk category has the largest number of transactions with thirty-five percent, followed by skim milk with twenty-eight percent of all transactions, then whole milk with twenty percent, and, with the least number of transactions, low-fat milk at seventeen percent.

The average number of transaction per household annually for all white milk is about thirty-four purchases. Twenty and one-half of those purchases are for gallon-sized containers; ten and one-half are half-gallon size purchases with the remaining three purchases being for the quart size. Statistics for the other fat types are available in Table 17. Table 18 shows monthly transaction activity by container type.

Table 17. Transaction Activity by Fat Type and Container Size

Container Size	Number of Transactions	Percent of Transactions by Category Sales	Percent of Transactions of All Milk Sales	Average Number of Transactions Annually Per Household
		All White Milk		
Gallon	147,464	-	60%	20.5
Half-Gallon	75,357	-	31%	10.5
Quart	21,092	-	9%	2.9
Total	222,821	-	100%	
		Whole Milk		
Gallon	28,299	59%	12%	3.9
Half-Gallon	14,289	30%	6%	2
Quart	5,418	11%	2%	0.8
Total	42,588		20%	
		Reduced Fat Milk		
Gallon	55,502	66%	23%	7.7
Half-Gallon	23,268	27%	10%	3.2
Quart	5,958	7%	2%	0.8
Total	78,770		35%	
		Low-fat Milk		
Gallon	25,782	55%	16%	3.6
Half-Gallon	13,864	35%	10%	1.9
Quart	2,427	11%	3%	1.0
Total	39,646		28%	
		Skim Milk		
Gallon	37,881	55%	16%	5.3
Half-Gallon	23,936	35%	10%	3.3
Quart	7,289	11%	3%	1.0
Total	61,817		28%	

Table 18. Percent of Transactions by Month

Month	Gallons	Half-Gallons	Quarts
January	8.74%	8.77%	8.43%
February	8.13%	8.29%	7.97%
March	8.98%	8.65%	8.79%
April	8.47%	8.45%	8.21%
May	8.71%	8.54%	8.61%
June	8.10%	8.26%	8.33%
July	8.37%	8.41%	8.54%
August	8.37%	8.47%	8.44%
September	8.05%	8.08%	8.38%
October	8.25%	8.46%	8.59%
November	7.69%	7.91%	7.70%
December	8.14%	7.71%	8.01%
	100.00%	100.00%	100.00%

Table 19 summarizes information about container type with respect to size. Plastic containers are most common for the gallon size making up 99 percent of all gallons sold, half-gallons are closely split between plastic and other types with 46 percent of the transactions being in plastic the remaining 54 percent in other than plastic containers. The quart size container has the most transactions for containers other than plastic, with 85 percent and the remaining fifteen percent of transactions being made in plastic containers.

Table 19. Container Type Information by Container Size

	Container Size		
Container Type	Gallons	Half-Gallons	Quarts
Plastic	99%	46%	15%
Non-plastic	1%	54%	85%

The number of transaction fluctuates from month to month. Figure 4 gives a clear visualization of these monthly fluctuations.

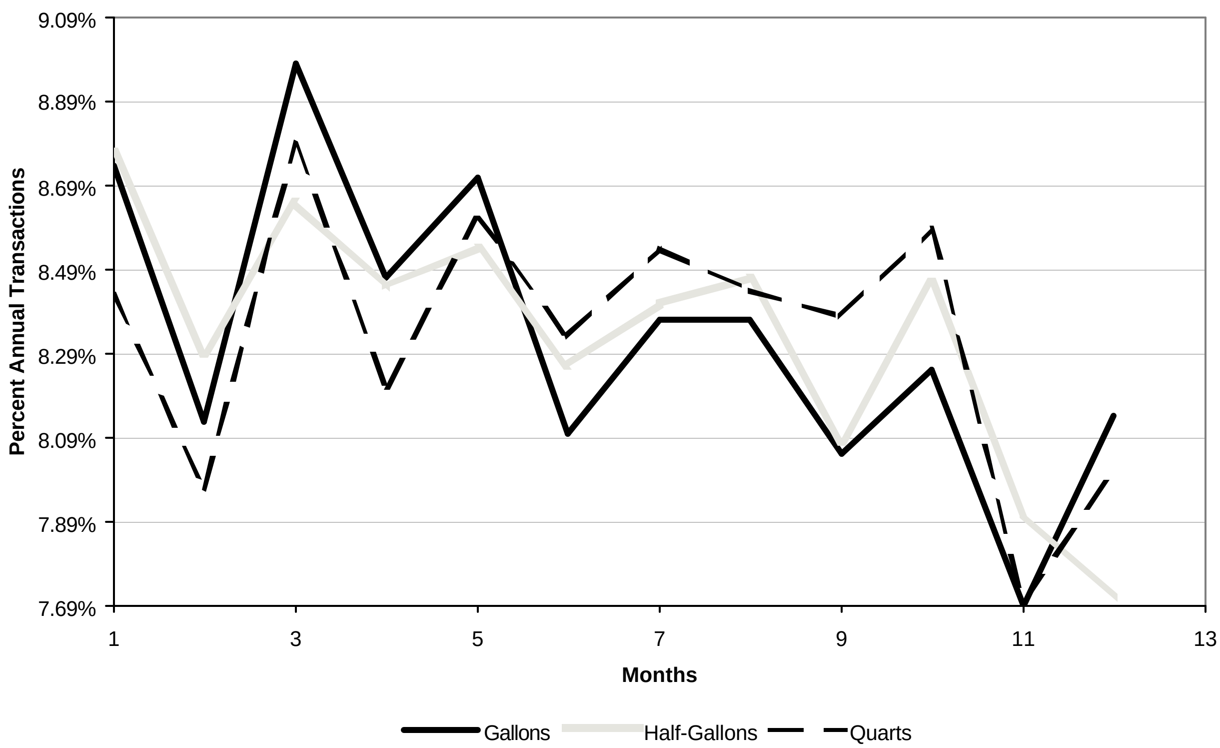

Figure 4. A Graph of percent of annual transactions by month

However transaction activity only ranges between a high of 8.9 percent to a low of 7.69 percent.

Table 20 shows the percentages of transactions made by brand type. Name brand products account for 34 percent of all the gallon transactions, 45 percent of the half-gallon size transactions, and for 54 percent of the quart size transactions. This indicates that as the size of the container increases the percentage of private label transactions also increases.

Table 20. Brand Classification by Container Size

	Brand Classification		
Brand Type	Gallons	Half-Gallons	Quarts
Branded	34%	45%	54%
Private Label	66%	55%	46%

Methodology

Critical to the implementation of the Nerlovian hedonic methodology is the keystone that prices be exogenous. The basis for assuming exogenous prices for retail fluid milk is logical. The commodities in the ACNielsen home scan (HSD) data set are items sold in retail stores recorded at the time of purchase by households at home. The data set is representative of individual consumers/households buying as much as they wish of any one of the commodities at the listed or posted price offered by any particular store. If one accepts that this condition holds, then prices may be considered exogenous. If prices are exogenous, which implies that the supply curve is perfectly elastic, consumers can buy all they wish of any item at its posted price. Nerlove labels this case as polar case two. Nerlove has shown that, in this case, the appropriate econometric estimation methodology is with the dependent variable as quantities (NHPE methodology) in lieu of prices.

Nerlove's main point for offering an alternative to the standard or Waughian hedonic price estimation (WHPE) methodology is based on the recognition that prices may be exogenous. In only two special cases of market structure can the direct estimation of hedonic prices when made result in estimates that are free from identification issues.

These two methods are polar opposites with regard to the assumptions about market conditions, which justify their appropriate application. The market structure conditions are carried over into the construction of the particular econometric models, which further lead to different specifications and use of variables in the actual estimation. Since the specifications and estimation variables are different, it is expected that the estimates themselves would be quite different. Given these facts and to illustrate the importance of properly applying the correct hedonic price model, both hedonic methodologies, NHPE and WHPE, are implemented using a linear functional form.

To reiterate Nerlove's point about the difference in the two models, the comparison between the estimates is a statement about the difference in outcome when there are differences in the price discovery process. What this means is that the resulting estimates are really not comparable. Rather, a comparison of results is an illustration of how different the estimates would be given different market structures. It must also be remembered that the NHPE and WHPE are only valid given the two extremes in the price discovery process, and that any other market structure involves identification issues that must be addressed using some other type of model.

The three NHPE models are estimated using quantity as the dependent variable. As Nerlove states, “we should regress the quantities consumed on the unit variety price and the measures of quality attributes which characterize that variety, Q(Z) = R[P(Z), a(Z), Y].”. Noting that P, price, is a function of Z attributes, a(Z) represents consumers’ valuation of various quality characteristics, and Y is a vector of income and other consumer characteristics. The standard or WHPE model is less complex and, using Nerlove’s notation, would be written as P(Z) = G[a(Z), Y].

Nerlove uses a double log specification, but other types of specifications could be used. For the purposes of this paper and to maintain manageability, only the linear functional form is used. There are three unit sizes, gallon, half-gallon, and quart. A total of six models are constructed and compared, three models of the NHPE and three WHPE. The three models of each type were done by container size. Hedonic price models are used to separate out the price effects of different attributes or characteristics of a particular good in this case the Z’s, a vector of attributes. The variables $a(Z_i)$ are interpreted as the consumer’s valuation of the i^{th} attributes of fat types, container types, and brands. Y denotes the inclusion of variables into the model to account for demographic differences and seasonality. An indicator variable for each of the months but one was included, with the exception of December, the base month. The hedonic process is repeated for each of the three different container sizes of milk.

It should be noted that white milk is categorized into four fat levels of whole fat (WM), reduced fat (RM), low fat (LM), and nonfat (NM) levels. There are four different container types, cardboard, glass, plastic, and pouch. However, very few observations are available for the pouch and glass container types, making it logical to combine all other non-plastic containers as one group. Combining container types reduces the number of categories to two, plastic or non-plastic. Brand type is either classified as private label, in house brand, or as proprietary or name brand. An inclusion of all the many brands would make the estimation quite unwieldy given that there are a large number of brands. The brand simplification is efficient but still provides a useful division that manufacturers' or name brand owners, and store chains, private label owners would find useful. Milk generally is associated with seasonal consumption and is therefore modeled with monthly indicator variables. The mathematical representation of the two models is presented in Figure 5, the NHPE equation and model, and Figure 6, the WHPE equation and model.

$$(4\text{-}1) \quad Q_{tp} = \beta_{p0} + \rho_p V_{tp} + \sum_{i=1}^{22} \gamma_{pi} X_{tpi} + \sum_{j=1}^{11} \beta_{pj} Y_{tpj} + \sum_{k=1}^{5} \alpha_{pk} Z_{tpk} + \eta_{tp}$$

Equation 4-1 The Nerlovian Hedonic Price Equation (NHPE) model

Q_{tp} - is the quantity for the t^{th} transaction and the p^{th} container size. Where p = gallons, half-gallons, or quarts, and t = the number of transactions.
β_{p0} – the base effect of the p th container size, where p = gallons, half-gallons, or quarts.
ρ_P - estimated effect of the p^{th} container size. Where p=gallons, half-gallons, or quarts.
V_{tp} – the price of the p^{th} container size for the t^{th} transactions.
γ_{pi} - is the parameters estimate for the effect for p^{th} container size and the i^{th} demographic indicator variable, where p = gallons, half-gallons, or quarts, and i = 1 to 22 demographic variables.
X_{tij} - the presence of the i^{th} demographic, for the p^{th} container size and t^{th} transaction. Where j = 1 to 11, p = gallons, half-gallons, or quarts, and t = number of transactions.
β_{pj} - beta is the parameter estimate for the p^{th} container size and the j^{th} month. Where p = gallons, half-gallons, or quarts, and j = 1 to 11 months.
Y_{tpj} - the presence of the j^{th} month, for the p^{th} container size and t^{th} transaction. Where j = 1 to 11, p = gallons, half-gallons, or quarts, and t = number of transactions.
α_{pk} - alpha is the parameter estimate of the marginal effects of the k^{th} attribute for the p^{th} container size. Where k = 5 attributes, and p = gallons, half-gallons, or quarts.
Z_{tpj} - the presence of the k^{th} attribute, for the p^{th} container size and t^{th} transaction. Where k = 1 to 5, p = gallons, half-gallons, or quarts, and t = number of transactions.
η_{pt} - the unexplained residual for the p^{th} container size and the t^{th} transaction. Where p = gallons, half-gallons, or quarts and t = number of transactions.

Figure 5. The NHPE equation and model

To justify the inclusion of the demographic variables in each of the six models, the eleven groups of demographic and seasonal adjustment variables were tested using F-tests. The null hypothesis for these F-test, by groups is that the effects of the specific group of demographic variables or seasonal variables are jointly equal to zero. Each of the models has a different demographic or seasonal variables that is found not to be significantly different from zero, except in the NHPE model for half-gallons which has no group or seasonal variables where the null hypothesis is not rejected.

(4-2) $$P_{tp}" = b_{p0}" + \sum_{i=1}^{22} g_{pi}" X_{tpi} + \sum_{j=1}^{11} b_{pj}" Y_{tpj} + \sum_{k=1}^{5} a_{pk}" Z_{tpk} + w_{tp}$$

Equation 4-2 The Waughian Hedonic Price Equation (WHPE) model

P_{tp}" - is the unit price for the tth transaction and the pth container size. Where p = gallons, half-gallons, or quarts, and t = the number of transactions for the WHPE model.
β_{p0}" - the base effect of the pth container size, where p = gallons, half-gallons, or quarts.
γ_{pi}" - is the parameters estimate for the effect for pth container size and the ith demographic indicator variable, where p = gallons, half-gallons, or quarts, and i = 1 to 22 demographic variables.
β_{pj}" - beta is the parameter estimate for the pth container size and the jth month. Where p = gallons, half-gallons, or quarts, and j = 1 to 11 months.
Y_{tpj} - the presence of the jth month, for the pth container size and tth transaction. Where j = 1 to 11, p = gallons, half-gallons, or quarts, and t = number of transactions.
α_{pk}" - alpha is the parameter estimate of the marginal effects of the kth attribute for the pth container size. Where k = 5 attributes, and p = gallons, half-gallons, or quarts.
Z_{tpj} – the presence of the kth attribute, for the pth container size and tth transaction. Where k = 1 to 5, p = gallons, half-gallons, or quarts, and t = number of transactions.
w_{pt} - the unexplained residual for the pth container size and the tth transaction. Where p = gallons, half-gallons, or quarts and t = number of transactions.

Figure 6. The WHPE equation and model

The gallon size models for the WHPE and NHPE each have one demographic group dropped. The WHPE dropped the demographic group “no children present”, and the NHPE dropped the ethnic origin group of Hispanic. Table 21 shows the gallon size WHPE and NHPE models F-test summaries.

The half-gallon size group F-test found in Table 22 indicates that the WHPE model has four groups dropped: (1) employment of the female head of house, (2) education of the female head of house, (3) ethnic origin of Hispanic, and (4) household sizes. As previously mentioned the half-gallon NHPE model had no demographic or seasonal variables dropped.

Table 21. Demographic Group F-test for Gallon Size

	Waughian Model		Nerlovian Model	
Demographic Group	F Statistic	p-values	F Statistic	p-values
Age of FHH*	124.91	0.000	25.73	0.000
Employment Status FHH*	10.69	0.000	58.05	0.000
Education of the FHH*	46.18	0.000	14.54	0.000
Race	4.01	0.018	74.33	0.000
Hispanic	9.69	0.002	**0.97**	**0.324**
Non City Dwelling	64.89	0.000	13.36	0.000
Region	896.16	0.000	1285.76	0.000
Martial Status	50.47	0.000	17.63	0.000
No Children Present	**0.03**	**0.869**	17.11	0.000
Household Size	24.38	0.000	459.77	0.000
Seasonal Effect, Months	858.35	0.000	7.67	0.000

- FHH, Female Head of Household

The **bolded** values are the variables dropped from the models.

Table 22. Demographic Group F-test for Half-Gallon Size

	Waughian Model		Nerlovian Model	
Demographic Group	F Statistic	p-values	F Statistic	p-values
Age of FHH*	7.79	0.00	33.70	0.00
Employment Status FHH*	**2.68**	**0.07**	9.26	0.00
Education of the FHH*	**1.62**	**0.20**	20.12	0.00
Race	249.60	0.00	17.62	0.00
Hispanic	**1.75**	**0.19**	32.57	0.00
Non City Dwelling	465.82	0.00	75.29	0.00
Region	1603.78	0.00	155.44	0.00
Martial Status	31.21	0.00	26.41	0.00
No Children Present	24.73	0.00	19.24	0.00
Household Size	**1.19**	**0.31**	360.39	0.00
Seasonal Effect, Months	120.44	0.00	6.09	0.00

*FHH, Female Head of Household

The F-test for the Quart-size model results in five groups of demographic and seasonal variables being removed from the two models, three from the WHPE model and two from the NHPE model. The three groups removed from the WHPE are (1) employment of the female head, (2) ethnicity of Hispanic, and (3) no kids present in the household. The two groups removed from the NHPE model are (1) Hispanic ethnicity, and (2) the seasonal variables group. Table 23 shows a summary of the demographic groups and seasonal variables F-test results.

Table 23. Demographic Group F-test for Quart Size

	Waughian Model		Nerlovian Model	
Demographic Group	F Statistic	p-values	F Statistic	p-values
Age of FHH	17.00	0.000	10.54	0.000
Employment Status FHH	**0.31**	**0.736**	28.71	0.000
Education of the FHH	14.37	0.000	37.54	0.000
Race	59.43	0.000	4.22	0.015
Hispanic	**1.20**	**0.273**	**0.17**	**0.679**
Non City Dwelling	366.48	0.000	12.74	0.000
Region	919.61	0.000	8.29	0.000
Martial Status	9.56	0.000	7.77	0.000
No Children Present	**3.31**	**0.069**	11.03	0.001
Household Size	27.80	0.000	24.16	0.000
Seasonal Effect, Months	15.89	0.000	**0.96**	**0.485**

* FHH, Female Head of Household

After the removal of the demographic and seasonal variable groups the models are estimated. In the case of the NHPE model it is necessary to use the coefficient estimates to impute the price for the NHPE model. The hedonic price for the NPHE model does not have the same interpretation as standard or WHPE model. The NHPE hedonic price is defined as the consumer's willingness to pay, given the ceteris paribus condition that quantities are held constant. The WHPE model hedonic price is interpreted as the marginal effects of the attributes on price.

The marginal implicit value for an attribute in the WHPE is simply the derivative dP/dZ_i. Setting the total derivative of the NHPE function equal zero and solving for the dP/dZi derives the NHPE hedonic price, or willingness to pay. When calculating the hedonic price for either of these models it is assumed that there are no changes in any of the demographics or that the change in the demographic variables is zero so the Y's drop out of both equations. Figure 7 shows the general mathematical manipulations used to derive the partial dP/dZ_i for the NHPE model.

$dQ = (\partial R/\partial P)\, dP + (\partial R/\partial Zi)dZi$

Where $dQ = 0$

Solve to get

$dP/dZ_i = - (\partial R/\partial Z_i/\partial R/\partial P)$.

Figure 7. The mathematical derivation of the Nerlovian hedonic price equation

Therefore, by holding quantity constant and allowing attributes to change, for example, changing price and attribute mix, a change in price with respect to a change in attributes results. Remember that although the derivatives look the same, the estimated models are based on different sets of assumptions and therefore are not comparable.

To help clarify the Nerlovian hedonic price a graphical example is given. See Figure 8. Let P_1 be the original price of the demand function $R_1(p,z)$, assume that the change in quantity is zero, thus quantity is fixed at Q*. Then a change in characteristic z, z being a good attribute and assuming the change in z is positive, a more desirable characteristic mix results in an outward demand shift, $R_2(p,z)$. In order to keep quantity fixed at Q* with this demand shift requires that the price must rise to P_2. This simple graph illustrates this condition and helps clarify why the Nerlovian hedonic price it is not comparable to the Waughian hedonic price.

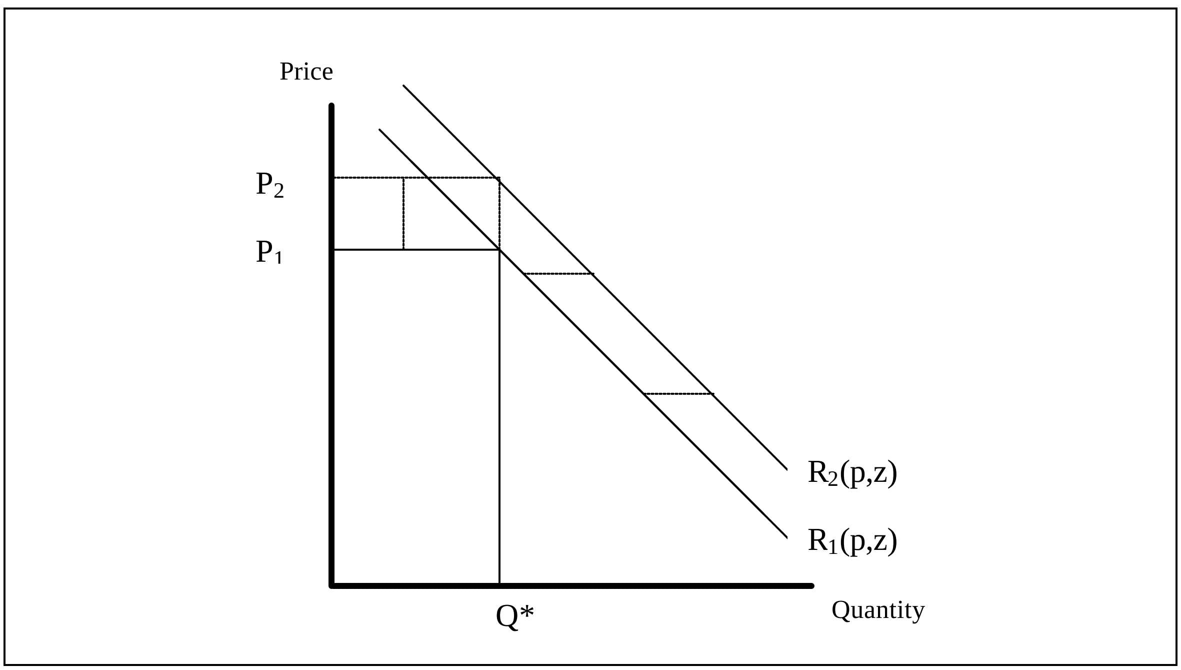

Figure 8. *Ceteris Paribus* conditions of the Nerlovian hedonic price model

Operationally, the NHPE is derived as the negative of the coefficient of the attribute α_{pk}, divided by the coefficient of the price variable $\rho_{P,}$ both from the NHPE model. This procedure is repeated for each k^{th} attribute. The delta method is used to test the NHPE hedonic prices, since each estimate is a combination of primal estimated parameters. This testing procedure is done using the Shazam test statements. The hedonic prices for the WHPE model are simply the coefficients α_{pk}", for a specific container size p, and k^{th} attribute and requires no other special testing procedure to test statistical significance, other than the student t test. To show how different the NHPE's are from the WHPE's they are both put into the same table. A separate table was constructed for each of the three container sizes.

Results

The complete list of coefficient estimates and their respective standard errors, t-statistics, and p-values are in Appendix D. Also in Appendix D a measure for goodness-of- fit, R-square, for each model provided.

Before going further into the detailed results it is helpful to re-emphasize the difference between the interpretations of the two models' hedonic price estimates. The NPHE estimates are interpreted as the consumers' willingness to pay based on transactional quantities. Therefore, the final estimates are reflective of the average consumer's willingness to pay for specific attributes while holding quantities constant. The WHPE model is the average marginal implicit valuation of the characteristic. The

WHPE uses the per unit price per transaction as the dependent variable, whereas the NHPE uses a per transaction quantity as the dependent variable.

The NHPE model for the gallon size has all positive coefficients except for whole milk. Since private label reduced fat milk in the plastic container is the base, and variation from base is what the estimates measure, branded milk, skim milk, low-fat milk, and non-plastic containers are positively valued while whole milk has a negative value. The negative value is representative of a willingness to accept a discount. All of the estimates are statistically significant for both the NHPE and WHPE models as shown in Table 24. The magnitude of the hedonic price estimate for non-plastic container type, is quite large, nearly 380 cents. This inflated value is more than the average price per gallon. This large value may stem from several sources. One cause may be the fact that such a small number of the containers in the gallon size are non-plastic, less than 1%. Although the number of observations associated with the container type attribute is small, the effects are consistently large, making the estimate of the coefficient for container type large relative to the price coefficient and resulting in the current hedonic price imputation for container type.

The consumers' willingness to pay for branded gallons of milk was 21.95 cents. Consumers who bought branded milk were willing to pay 21.95 cents more than for unbranded gallons of milk. The WHPE model estimated the average marginal valuation of branded milk as 6.54 cents, representing the average transactions valuation over all consumers greater than the base price.

The WHPE hedonic price estimate for non-plastic containers was 17.51 cent less than the base container type, plastic, while the NHPE price was 379.13 cents higher than the base. As mentioned, the cheaper price of non-plastic containers and the increased quantity per transaction, with the assumption of fixed quantities results in this large NHPE estimate.

The marginal implicit price for skim milk derived from the WHPE model was -6.71 and the NHPE willingness to pay of those who consumed skim milk was 16.43 cents higher then that for two percent milk. When quantities are unchanged those that consume skim milk are willing to pay 16.43 cents more than for reduced fat milk.

Table 24. Hedonic Models – Gallon-Size Containers

Attribute , Z_i	**NHPE, (dR/dZ_i)**	**-(dR/dZ_i)/(dR/dP)**	**WHPE, (dG/dZ_i)**
Brand vs. Private Label	0.0227	21.95	6.54
p-values	0.00	0.00	0.00
Non-Plastic Container	0.3920	379.13	-17.51
p-values	0.00	0.00	0.00
White Skim milk	0.0170	16.43	-6.71
p-values	0.00	0.00	0.00
White Lowfat milk	0.0297	28.75	0.834
p-values	0.00	0.00	0.02
White Whole milk	-0.0253	-24.50	14.94
p-values	0.00	0.00	0.00
(dR/dP) from the NHPE =		-0.0010	
p-value		0.00	

See Figures 5,6 and 7 for definitions and explanation of the headings and acronyms.

Low-fat milk has an average marginal attribute value of less then one cent over two percent fat milk, but the willingness to pay is 28.75 cents more then for two percent fat milk. The willingness to pay stems fro the larger sizes of the transaction quantities of low-fat milk relative to reduced fat milk.

Whole milk in the gallon size has an average marginal attribute value of 14.53 cents more than that of reduced fat milk. The willingness to pay for unchanged quantities low-fat milk is 24.50 cents less than reduced fat milk. Whole milk as an attribute decreases quantity per transaction relative to reduced fat milk as seen from the coefficients of the NHPE model. Therefore, the constant quantity assumption, in the presence of a negative sloping demand function causes the willingness-to-pay of consumers to also be negative.

From Table 25, which shows the half-gallon size container results, all five of the attribute coefficients for the WHPE model are positive. The NHPE model has positive coefficient estimates for two attributes, brand and non-plastic containers while the remaining three coefficients for the three fat types, skim milk, low-fat milk, and whole milk are negative. Fat types have a negative impact on price relative to reduced fat milk. In the WHPE model all fat types have a positive effect making the average price paid for fat types being higher than the base showing a positive effect on price.

Consumers who bought branded milk are willing to pay 40.68 cents more then for unbranded half-gallons of milk, quantities remaining constant. The WHPE model estimates the average marginal valuation of branded half-gallons at 20.70 cents, making branded half-gallons that much more costly than private label half-gallons on average.

Table 25. Hedonic Models – Half-Gallon-size Containers

Attribute , Z_i	**NHPE, (dR/dZ_i)**	**-(dR/dZ_i)/(dR/dP)**	**WHPE, (dG/dZ_i)**
Brand vs. Private Label	0.0528	40.68	20.70
p-values	0.0000	0.00	0.00
Non-Plastic Container	0.0785	60.46	9.47
p-values	0.0000	0.00	0.00
White Skim milk	-0.0163	-12.58	8.39
p-values	0.0030	0.00	0.00
White Lowfat milk	-0.0120	-9.28	4.78
p-values	0.0590	0.06	0.00
White Whole milk	-0.0667	-51.41	3.82
p-values	0.0000	0.0000	0.0000
(dR/dP) from the NHPE =		-0.00130	
p-value		0.000	

See Figures 5,6 and 7 for definitions and explanation of the headings and acronyms.

The WHPE non-plastic container type hedonic price estimate is 9.47 cents more than the base container type, plastic. The NHPE price is 60.46 cents higher than the base, which is consistent with the higher price of non-plastic containers and the increased quantity per transaction.

The skim milk hedonic price for the WHPE model is a positive 8.39 cents and the NHPE willingness to pay for those who consumed skim milk is -12.58 cents both relative to reduced fat milk. On average, skim milk implicit price is 8.39 cents more than reduced fat milk. To maintain unchanged quantities, those that consume skim milk would value it at being worth 12.58 cents less than reduced fat milk. This valuation is supported by the negative impact that skim milk has on the magnitude of the transaction quantity.

Low-fat milk has a marginal attribute value of 4.78 cents, but the willingness to pay is - 9.28 cents, both relative to reduced fat milk. Again, the negative outcome is the result of the negative effect that low-fat milk has on the transaction quantity relative to reduced fat milk.

Whole milk in the half-gallon size costs an average of 3.82 cents more than reduced fat milk, while the willingness to pay for unchanged quantities by consumers is 51.41 cents less than reduced fat milk. Whole milk, as an attribute, decreases quantity per transaction relative to reduced fat milk, and therefore given the constant quantity assumption, requires the willingness to pay of consumers to be a discount value or negative amount relative to the base.

The results for the final container size need special consideration because they have a unique outcome. The relationship between price and quantity is positive unlike the expected outcome when estimating a typical demand function. As seen in Table 26, the change in quantity with respect to price (dR/dP) is positive. This unexpected result affects the interpretation of the change in price with respect to the i^{th} attribute (dP/dZ_i) for the NHPE model. The mathematical relationship used to derive dP/dZ_i is determined by the negative of the ratio of the change in quantity with respect of the i^{th} attribute (dR/dZ_i) and dR/dP, which when dR/dP is positive, makes the NHPE hedonic price of opposite sign of the dR/dZ_i. Whatever attribute has a positive effect on quantity, will have the opposite effect on the hedonic price, and if the attribute effect is negative on quantity it has a positive effect on hedonic price.

Table 26. Hedonic Models – Quart -Size Containers

Attribute , Z_i	**NHPE, (dR/dZ_i)**	**-(dR/dZ_i)/(dR/dP)**	**WHPE, (dG/dZ_i)**
Brand vs. Private Label	0.0512	-114.35	13.38
p-values	0.000	0.001	0.000
Non-Plastic Container	0.0328	-73.28	-10.96
p-values	0.002	0.008	0.000
White Skim milk	0.0216	-48.26	6.67
p-values	0.013	0.039	0.000
White Lowfat milk	-0.00048	1.0787	9.03
p-values	0.968	0.968	0.000
White Whole milk	-0.0270	60.33	-1.15
p-values	0.004	0.018	0.052
(dR/dP) from the NHPE =		0.00045	
p-value		0.000	

See Figures 5,6 and 7 for definitions and explanation of the headings and acronyms.

Given these unusual conditions, the consumers' willingness to pay for branded quarts of milk is -114.35 cents. Since the hedonic price for the NHPE model requires quantity to remain fixed, a discount of 114.35 would have to be made on branded quarts to reduce quantity per transaction. Remember that in this case the relationship between the price and quantity is estimated to be positive. The WHPE model has no quantity relationship issues and is free from this effect. In addition, it has a positive average marginal valuation of 13.38 cents, implying that the overall transactions valuation of brand is 13.38 cents higher than that of the base.

The WHPE non-plastic containers hedonic price estimate is -10.96 cent less than the base container type, plastic. The NHPE price also is 73.29 lower than the base. The cheaper price of non-plastic containers the increased quantity per transaction, and the fixed quantity assumption, require that the estimated hedonic price be a discount of 73.28 cents.

The skim milk hedonic price for the WHPE model is a positive 6.67 cents and the NHPE willingness to pay for those who consumed skim milk is -48.26 cents, both relative to the base of reduced fat milk. Again, holding quantities constant, those that consume skim milk need to be willing to discount its value by 48.26 cents compared to two percent fat milk. The positive demand relationship forces the discount in order that quantity per transaction remain balanced.

Low-fat milk has a marginal attribute value of 9.03 cents, with a willingness to pay of 1.08 cents. The negative effect low-fat milk has on the transaction quantity assures that the willingness to pay is positive.

Whole milk in the quart size has an average marginal valuation of -1.15 cents, the willingness to pay for unchanged quantities was 60.33 cents more than the base reduced fat milk. The whole milk attribute decreases quantity per transaction relative to reduced fat milk, therefore the constant quantity assumption and positive demand relationship cause the willingness to pay of consumers to be positive relative to the base.

In a comparison of the WHPE estimates among the three container size models, differences can be seen between average attribute valuations. The attribute effects of brand and low-fat milk are positive for all container sizes. The container type attribute non-plastic is negative in the gallons and quarts models and positive for the half-gallon model. For skim milk, effects on average price are also mixed by size, with a negative effect for the gallon size and positive effects for the half-gallon and quart sizes. Whole milk has a negative effect on average price for the quart size, and a negative effect for both the gallon and half-gallon sizes. Only one effect is not statistically significant at the five percent level, that being whole milk in the quart size model.

Only the NHPE half-gallon and gallon models are compared. The quart model is not used since the estimate of dR/dP is positive, reversing the sign of the hedonic price estimates relative to the outcome of the other two models. The estimates for the two models are of like sign for the attributes of branded, container type, and whole milk. The branded hedonic prices for branded and non-plastic containers are positive, and those for whole milk are negative. The remaining two hedonic price estimates for the attributes skim and low-fat milk are opposite in sign. In both cases the half-gallon estimates for these two attributes are negative and the gallon estimates are positive.

Conclusion

The WHPE model estimates are considerably different, either in sign or magnitude for all considered attributes when compared to the NHPE model. This result really comes as no surprise considering the difference between the models. The WHPE model shows the effects characteristics have on price, while the NHPE model considers the effect characteristic have on quantity. These relationships are then translated into a hedonic price by holding quantity fixed and using the price quantity relationship to derive the consumers' willingness to pay.

General statements can be made about the effect of different container sizes. Container sizes with identical attributes do not have the same effect on consumers' willingness to pay, nor do they have the same effect on average marginal valuation. Container size does affect the magnitude and direction of hedonic values.

The NHPE quart size model gives rise to an anomalies result, a positive price quantity relationship, opposite of what is expected from theory. Some exploratory work using other functional forms, a logged income version and quadratic income term added to the models did not change the price quantity relationship. Further work on other years of data may prove helpful in determining if the result found here truly is an anomaly.

Identification plays a crucial role in determining the appropriate model. Nerlove's hedonic price estimates tell a story that relates to an adjustment for quantity considerations. Appropriately, these hedonic price estimates relate to the effect price plays in balancing a set quantity. Although not as simply understood as traditional or Waughian hedonic prices, the Nerlovian hedonic price estimates provide valuable information.

CHAPTER V

A DEMAND SYSTEM ANALYSIS WITH EMPHASIS ON CONTAINER SIZE OF FLUID MILK

Background

This chapter of the dissertation exploits information-rich scanner data through the use of a demand system designed to extract elasticity information of commonly purchased non-alcoholic beverages, especially fluid milk products, by container size. From a recent summary on trends in milk consumption, it is evident that changes in milk consumption are anything but static (Nyman and Capps). The trends in dairy food and beverage products were reflective of changes in demographics, population composition, income distribution, and other factors as well as taste and preferences. The past several decades have seen the proliferation of products that potentially compete with milk as a beverage. This contention is evident from the ever-increasing number of non-alcoholic beverages. These facts further support the need for a more rigorous and detailed examination of consumer behavior for non-alcoholic beverages.

In all of the literature on milk demand no research study yet has investigated the effect of container sizes on elasticity estimates for milk or non-alcoholic beverages. To date most studies on milk and other non-alcoholic beverages aggregate all of the products included in the demand system into a single container size measure, the gallon. An exception to note, which uses the half-gallon as the normalized measure, was the study by Glaser and Thompson. Interestingly Glaser and Thompson use the half-gallon measure by default, since the primary focus of their work was on organic milk, which was at the time almost exclusively sold in half-gallons.

Among the likely reasons applied economists have shown a preference for demand systems that have a single unit measure results from extensive application of the LA/AIDS model. The LA/AIDS model is generally applied with the inclusion of the Stone index to linearize the system of equations. It has been shown that the Stone index creates a biased estimate of the parameters when the unit measures of the right-hand side variables in the demand equations are not in uniform unit measures. (Moschini).

The departure from the single unit measurement demand system is a step away from the traditional approach, and a step toward isolating the effect characteristics have on consumer behavior. Elasticity information by container size, which is hidden in any aggregated demand model, can be more clearly identified. These more sophisticated demand systems can generally be supported by home scan data (HSD).

Package aggregation hides differences in the qualities or characteristics that makeup the aggregated commodity. Knowing that households in the 1999 ACNielsen survey data bought milk in various container sizes and then ignoring that by aggregating all purchases as if only one quantity size were bought, implies that the price relationships estimated from such an aggregation is the result of some kind of weighted relationship among container sizes. The problem is not that the estimated coefficients and resulting elasticities are weighted, but rather there is no way to disentangle the value of the weights that makeup these estimates of the aggregated demand system. Therefore, there is no way to measure the effect that a single characteristic, such as container size, has on consumer price and quantity response. It is, however, the relationships of the disaggregated products that tell the more complete story. Price relationships, which take into account container size, provide valuable decision-making information and a clearer vision of how the non-alcoholic beverage market functions for at-home consumption. This information could prove invaluable to stakeholders in the milk and non-alcoholic beverage arena.

In capturing the price effects by container size in a demand system, a much more detailed understanding of the interrelationships between milk and other non-alcoholic beverages are possible. Beverages included in this work are commonly found in the demand literature as well as on the supermarket shelf. Carbonated soft drinks (CSDs) are included in most studies about non-alcoholic beverages, which is no surprise since they have been on an increasing trend for the last couple of decades and are the most commonly sold non-alcoholic beverage.

According to Nyman and Capps the estimated per capita consumption of CSDs in 1998 was in excess of fifty gallons annually (Nyman and Capps). Bottled water, juices, and flavored milk also have been on the increase and compete for a place in the bundle the consumer purchases. In this study a demand system with these five beverages in varying containers sizes was considered. The inclusion of different container sizes makes this beverage research unique when compared to previously published research. Table 27 provides a complete list of the beverage products and the container size groupings applied in the demand system.

The demand system provides several types of price information, including own-price, cross-price and expenditure elasticities. When these common measures of price effects are considered in the context of container size, i.e., cross-price elasticities, they represent the substitutability or complementary nature of beverages of different types and sizes. For the first time, relationships among various container sizes as well as types of non-alcoholic beverages are definitively and empirically available.

Table 27. Beverages Estimated in the Demand System

Variable Number	Variable Description	Container Sizes
1	Fruit and Vegetable Juices	Quart
2	Fruit and Vegetable Juices	Half-Gallon
3	Fruit and Vegetable Juices	Gallon
4	Bottled Water	Half-Gallon
5	Bottled Water	Gallon
6	Carbonated Soft Drinks	Pint
7	Carbonated Soft Drinks	Quart
8	Carbonated Soft Drinks	Half-Gallon
9	White Milk	Quart
10	White Milk	Half-Gallon
11	White Milk	Gallon
12	Flavored Milk	Quart
13	Flavored Milk	Half-Gallon

The estimation of the thirteen-product demand system in Table 27 provided the coefficients that allowed the calculation and statistical testing of one hundred and eighty-two elasticity estimates, one hundred and fifty-six cross-price effects, thirteen own-price effects, and thirteen expenditure elasticities.

Literature Review

As mentioned in the introduction, no published research study has ever considered the effect of container sizes on elasticity estimates for milk or non-alcoholic beverages. A single staff paper and related dissertation was found that addressed the brand-size relationship of spaghetti products (Changwon and Senauer). However, this demand system used a logit-type demand system, designed to estimate the probabilities associated with consumer choices. This logit model focused on the brand-size effect in relation to advertising. Therefore only elasticities associated with advertising were estimated, and not the typical own-price and cross-price elasticities.

Many studies have investigated milk demand but one of the first to estimate a demand structure for fluid milk products was Rojko. In his 1957 work Rojko used time series data to estimates single-equation demand models for fluid milk, cream, butter, and other manufactured dairy products.

Since this first study by Rojko, many different types of studies have been undertaken using different types of data, as can be seen in Capps' literature review done in 2003. A classic example of using disappearance data was that of the 1990 milk demand study by Gould, Cox, and Perali. Gould, Cox, and Perali applied the LA/AIDS model and investigated demographic changes over time and their effect on demand for whole and low-fat milk.

Much of the more current demand work applies a demand systems approach with some type of survey or scanner data. Of the many different papers published, two are representative of the issues that arise when estimating a demand system using these types of data.

Schmit, Chung, Dong, Kaiser, and Gould used a Heckman two-step procedure to perform single-equation estimates on household scanner data (HSD). One of the major purposes of using the Heckman procedure is to accommodate censoring. Glaser and Thompson used a series of four LA/AIDS models on half-gallon sizes of three different milk types, organic, branded white milk, and private label white milk. Each one of the four models was reflective of a specific fat level. The fat levels used were whole milk, two percent fat milk, one percent fat milk, and non-fat milk. Although the reader is intrigued by their comments on the importance of different container sizes, they nonetheless use only the half-gallon size in their models.

The demand system used in this work includes many of the missing elements not included in previous research. First and foremost, this work uses a systems approach to address the price effects of the three most common container sizes of milk as well as the leading competing products in like sizes. Second, a methodology was used that accounts for censoring. The methodology proposed by Shonkwiler and Yen was applied. The Shonkwiler and Yen methodology uses a consistent two-step estimation procedure referred to as CTS. Much like the single-equation case and the method posed by Heien and Wessels (HW) the first stage requires a probit estimation. However, it is the second stage where the CTS diverge from the HW estimation procedure. There are several other methods of accounting for censoring in a demand system found in the literature, but many of these require the use of integrals, which may make the estimation of this size intractable (Yen et al. 2003).

Data

To transform the data into the appropriate form required several steps. The first step required identifying the appropriate modules that contain the needed beverage information. The second step was to extract the appropriate container size, price and quantity information from the selected modules. The third and fourth steps included consolidating the data into an annual cross section of households and checking and removing any anomalies.

The raw data set has two sub-groupings that contain modules of ready to serve non-alcoholic beverages. The dry grocery sub-group contains modules for juices of all kinds, CSDs, and bottled water. The dairy sub-group had two appropriate modules, one for white milk and another for flavored milk.

A single module contains many different types of information about its general product area. An example will help to clarify what is meant by module information. The module for white milk, #3625, has information on the characteristics of the various ways white milk was sold, such as container size and type, brand name, and fat type. The module also contains purchase information, such as household identification number, quantity of purchase, and expenditure and coupon or special purchase information.

For example, milk comes in gallon, half-gallon, quart, pint and half pint sizes, with a container that may be categorized as plastic, cardboard, pouch or glass. Additionally, the milk type is a designation of fat content and possibly origin such as soymilk, goat's milk, raw milk, as well as other types. The purchase information is based on transactions where homogeneous items purchased during a single trip to the store are recorded in number and total expenditure as a group.

Seventeen modules were combined to make the aggregated group called juice, while the CSD group was comprised of two modules. The bottled water, white milk, and flavored milk groups are made up of single modules. A list of the modules used to create the five-aggregated beverage groups are summarized in Table 28. Once the aggregations were decided upon, the next phase was to decide on appropriate container size assignments within each aggregate grouping.

Three of the five aggregate groups, juice, white milk and flavored milk are sold primarily in the container sizes of gallons, half-gallons, and quarts. CSDs and water follow a slightly different pattern that includes both the English and metric systems of volume measurement. However, for uniformity all five groups were measured in ounces and converted to the closest container size, such as pint, quart, half-gallon, or gallon.

Juices were divided into three container size groups, quart, half-gallon and gallon. Juice sold in containers holding between 16 ounces and 33.8 ounces were classed as quart size. Juice containers larger than 33.8 ounces and less than or equal to 67.6 ounces were classified as half-gallons. Any juice containers sold that were larger than 67.6 ounces were classified as gallons.

CSDs were grouped into the three sizes of pints, quarts and half-gallons. CSD containers 16 ounces or less are grouped as pints, while those containers holding more then 16 ounces and less than 57 ounces were grouped as quarts, and those greater than 57 ounces are classified as half-gallons.

Table 28. List of Used Modules and Assigned Aggregation Groups

Sub-Group	Module #	Description Title	Aggregate Group
Dry Grocery	1030	Fruit Drinks/Cranberry	Fruit Juice / FJ
Dry Grocery	1031	Cider	Fruit Juice / FJ
Dry Grocery	1032	Grapefruit Juice	Fruit Juice / FJ
Dry Grocery	1033	Apple Juice	Fruit Juice/ FJ
Dry Grocery	1034	Grape Juice	Fruit Juice / FJ
Dry Grocery	1035	Grapefruit Juice - Canned	Fruit Juice / FJ
Dry Grocery	1036	Orange Juice - Canned	Fruit Juice / FJ
Dry Grocery	1037	Lemon/Lime Juice	Fruit Juice / FJ
Dry Grocery	1038	Pineapple Juice	Fruit Juice / FJ
Dry Grocery	1039	Prune Juice	Fruit Juice / FJ
Dry Grocery	1040	Orange Juice	Fruit Juice / FJ
Dry Grocery	1041	Fruit Drinks - Canned	Fruit Juice / FJ
Dry Grocery	1042	Fruit Drinks	Fruit Juice / FJ
Dry Grocery	1044	Fruit Drinks Remaining	Fruit Juice / FJ
Dry Grocery	1045	Fruit Juice Nectars	Fruit Juice / FJ
Dry Grocery	1054	Vegetable Juice - Tomato	Fruit Juice / FJ
Dry Grocery	1055	Vegetable Juice Remaining	Fruit Juice / FJ
Dry Grocery	1484	Soft Drinks - Carbonated	CSD
Dry Grocery	1487	Water - Bottled	Bottled Water / BW
Dry Grocery	1553	Soft Drinks - Low Calorie	CSD
Dairy Food	3592	Flavored Milk	Flavored Milk / FM
Dairy Food	3625	White Milk	White Milk / WM

For bottled water, an appropriate grouping scheme was a difficult to decide on since to there was no clear uniformity of container size when compared to the other aggregate groups. To divide bottled water into more than two groups would cause the budget shares to become very small and possibly create econometric difficulties. From the data it was evident that larger size containers, such as gallons, are really inexpensive, even less that of the single liter size. However this larger container size is not convenient for carrying around, while the smaller containers are more expensive but are easily toted. Therefore two groupings were made, one of containers smaller than 67.6 ounces, and other of containers holding more than 67.6 ounces. The smaller container sizes were converted to half-gallon equivalents, while the larger sizes were converted to the gallon-size equivalents.

White milk was subdivided into three groups, with gallons being the most purchased size followed by half-gallons and then quarts. The quart size ranged between 16.1 ounces to 33.8 ounces, while the half-gallon size ranged from 33.9 to 101.4 ounces and the gallon size being any container greater than 101.4 ounces.

Flavored milk was divided into two groupings. The quart-size, which included any container less than 48 ounces in volume, and the half-gallon size being any container that was equal to or larger than 48 ounces in volume. In 1999 flavored milk had a fairly small budget share portion among non-alcoholic beverages, so dividing it into three groups, similar to white milk, would further compound censoring and elasticity estimation issues. Additionally, the majority of the flavored milk recorded as being purchased in the HSD data was in smaller than gallon-size containers, with the quart size more prevalent than the half-gallon size.

Once the modules were extracted from the raw data, aggregated and subdivided into one of the thirteen products, several things needed to be done to create the appropriate cross sectional data set. Demographic information was necessary to accommodate imputation of missing prices and for the estimation of the cumulative distribution function (cdf) and the probability density function (pdf) variables needed for the estimation of the censored model.

The HSD data came in the form of transactions. Each observation was date specific, with purchase and product characteristic information. The purchase information was shown as a total expenditure amount for the transaction. This expenditure was identified as “price paid deal” or “price paid non-deal” where the total actually spent by the household was the price paid non-deal if no promotion or coupon was present, or price paid deal minus coupon value in the event of a discount. The price paid for each item was the total expenditure for the transaction divided by the quantity bought in that transaction. Remember, a transaction is defined as the purchase of a single product type in a single time period. A transaction may be for only one item such as a single gallon of milk or for many items such as twenty-four, 12-ounce cans of a single type of CSD.

To create the annual cross-sectional data set to be used in this analysis an average price per household was calculated for each of the thirteen products. Tables 29 and 30 lists the descriptive price and quantity statistics from the final data set. The descriptive statistics are only for those households who purchased a positive quantity during the year

Table 29. Price Statistics for Households That Purchased the Thirteen Beverages

Beverage Type	Container Size	Number of Households That Purchased	Average Price	Standard Deviation	Minimum Price	Maximum Price
Fruit Juice	Quart	6,058	1.58	0.89	0.00	7.84
Fruit Juice	Half-Gallon	6,789	2.07	0.60	0.00	6.79
Fruit Juice	Gallon	3,952	3.36	1.41	0.00	9.72
Bottled Water	Half-Gallon	3,847	1.51	0.74	0.00	5.68
Bottled Water	Gallon	3,056	0.78	0.23	0.00	2.59
CSD's*	Pint	6,573	0.34	0.14	0.00	1.67
CSD's	Quart	4,807	0.93	0.37	0.00	3.87
CSD's	Half-Gallon	6,770	1.93	0.58	0.00	4.07
White Milk	Quart	2,789	1.12	0.32	0.00	3.80
White Milk	Half-Gallon	5,428	1.66	0.41	0.00	3.95
White Milk	Gallon	5,404	2.52	0.38	0.00	5.73
Flavored Milk	Quart	1,526	1.44	0.42	0.00	5.18
Flavored Milk	Half-Gallon	1,056	1.74	0.58	0.00	3.76

* CSD's is an acronym for Carbonated Soft Drinks

Table 30. Quantity Statistics for Households That Purchased the Thirteen Beverages

Beverage Type	Container Size	Number of Households That Purchased	Average Number of Units Purchased	Standard Deviation	Minimum Number of Units Purchased	Maximum Number of Units Purchased
Fruit Juice	Quart	6,058	22.16	33.44	0.08	558.30
Fruit Juice	Half-Gallon	6,789	25.99	29.85	0.69	324.70
Fruit Juice	Gallon	3,952	7.36	11.13	0.75	225.96
Bottled Water	Half-Gallon	3,847	10.02	21.98	0.13	452.05
Bottled Water	Gallon	3,056	16.75	36.76	1.00	430.00
CSD's*	Pint	6,573	273.99	408.70	0.75	17,613.00
CSD's	Quart	4,807	26.63	67.11	0.63	1,082.80
CSD's	Half-Gallon	6,770	31.70	35.93	0.93	455.92
White Milk	Quart	2,789	8.30	12.91	1.00	177.00
White Milk	Half-Gallon	5,428	16.24	24.03	0.89	597.00
White Milk	Gallon	5,404	34.11	36.71	1.00	376.00
Flavored Milk	Quart	1,526	3.72	6.65	0.25	116.00
Flavored Milk	Half-Gallon	1,056	6.36	13.80	1.00	241.00

*CSD's an acronym for Carbonated Soft Drinks.

of 1999. Included statistics are average price and quantity, standard deviations, minimum and maximum prices and quantities.

The average price was calculated by dividing the total annual expenditure for each product by household, by the total annual quantity bought of that product by that household. This price and quantity information was retained for each of the thirteen products for each household. In the event that a household did not purchase any of a particular product the price was unrecorded. Some households purchased product for a zero price.

The annual expenditure sum for each product by household was retained so that gross expenditures could be calculated as well as budget shares for each product. The final average budget shares range from just over 23% for CSD pints to less than 1% for flavored milk quarts and half-gallons. Table 31 shows all of the budget shares.

Prior to calculating the average annual price and quantities, several things were done to reduce anomalies in the final data set. By using Chebychev's inequality, any transactional prices greater than five standard deviations from the mean price of that product were dropped from the data set. Table 32 it can be seen that of the more than eight hundred thousand transactions less than two tenths of a percent were dropped. The Chebychev's inequality was performed prior to aggregation across households.

The next step in obtaining the usable data set was to add demographic information. The HSD data set has a demographic sub file with 18 different demographic categories. The eighteen categories are described in chapter two. All of the demographic information was added for each of the 7,195 households. By aggregating the data across households a cross sectional data set was created. Not all 7,195 households bought all thirteen products sometime during the year, and where no purchases were made, no observed price was recorded or budget share allotted to the purchase of that product. In order for the data set to be used appropriately in a demand system it was necessary to fill in the unobserved prices. This was accomplished through a first order imputation process. A full discussion of the methods and information used in these imputations is discussed in the methodology portion of this chapter.

Table 31. Average Budget Shares by Type and Container Size

Beverage Type	Container Size	Average Budget Share
Fruit Juice	Quart	6.8%
Fruit Juice	Half-Gallon	14.8%
Fruit Juice	Gallon	3.9%
Fruit Juices	All	25.5%
Bottled Water	Half-Gallon	1.9%
Bottled Water	Gallon	1.6%
Bottled Water	All	3.5%
CSD's*	Pint	23.4%
CSD's	Quart	3.9%
CSD's	Half-Gallon	16.7%
CSD's	All	44.0%
White Milk	Quart	1.1%
White Milk	Half-Gallon	6.1%
White Milk	Gallon	19.0%
White Milk	All	26.1%
Flavored Milk	Quart	0.3%
Flavored Milk	Half-Gallon	0.5%
Flavored Milk	All	0.8%

*CSD's an acronym for Carbonated Soft Drinks.

Additionally, a complete list of the demographic variables used is in Figure 9 and Appendix E. Only five households out of the 7,195 were found to have purchased none of the thirteen products; these households were excluded from the data set used in the final estimation of the demand system.

Table 32. Effect of Using Chebychev's Inequality with Five Standard Deviations

Product	# Of Observations Without Chebychev's	# Of Observations With Chebychev's	Number of lost Observations	Percent of Lost Observations
Fruit Juices Quarts	5,596	5,580	16	0.2859%
Fruit Juices Half-Gallons	4,720	4,720	0	0.0000%
Fruit Juices Gallons	147,388	147,388	0	0.0000%
Bottled Water Half-Gallon	75,669	75,669	0	0.0000%
Bottled Water Gallon	21,369	21,369	0	0.0000%
Carbonated Soft Drinks Pints	142,904	142,258	646	0.4521%
Carbonated Soft Drinks Quarts	48,887	48,873	14	0.0286%
Carbonated Soft Drinks Half-Gallons	144,574	144,309	265	0.1833%
White Milk Quarts	19,906	19,906	0	0.0000%
White Milk Half-Gallons	18,719	18,655	64	0.3419%
White Milk Gallons	25,832	25,832	0	0.0000%
Flavored Milk Quarts	155,958	155,955	3	0.0019%
Flavored Milk Half-Gallons	67,847	67,626	221	0.3257%
Totals	879,369	878,140	1,229	0.1398%

Methodology

Price Imputations

In order to estimate the demand system each of the households must have price information for each product. Since many of the households only purchased some of the products, prices for non-purchased products were not recoverable. By using the demographic variables a simple OLS regression was used to impute those missing prices.

An OLS regression was performed for each of the thirteen products using only those observations where price for the chosen product were observed. Figure 9 shows equation 5-1, the mathematical representation of the OLS regression equations and the explanation of the variables used for the price imputation. Appendix E has a summary of the outcome of the OLS coefficient estimates with standard errors, t-statistics and p-values.

$$
\begin{aligned}
P_{ih} = {} & \hat{\beta}_{0i} + \hat{\beta}_{1ih}*I_h + \hat{\beta}_{2ih}*H_{1h} + \hat{\beta}_{3ih}*H_{2h} + \hat{\beta}_{4ih}*H_{3h} + \hat{\beta}_{5ih}*A_{1h} \\
& + \hat{\beta}_{6ih}*A_{2h} + \hat{\beta}_{7ih}*A_{3h} + \hat{\beta}_{8ih}*C_h + \hat{\beta}_{9ih}*E_{1h} + \hat{\beta}_{10ih}*E_{2h} + \hat{\beta}_{11ih}*R_h \\
& + \hat{\beta}_{12ih}*J_{1h} + \hat{\beta}_{13ih}*J_{2h} + \hat{\beta}_{14ih}*S_h + \hat{\beta}_{15ih}*R_{1h} + \hat{\beta}_{16ih}*R_{2h} + \hat{\beta}_{17ih}*R_{3h} \\
& + \hat{\beta}_{18ih}*NM_h + e_{ih}
\end{aligned}
\tag{5-1}
$$

Equation 5-1. The OLS Regression equations used to impute missing prices.

Where i = {1,2,3,,,……13} number of products, and h = {1,2,3,,, ……7190} number of households, observations.

P_{ih} - Where P is the actual price of the ith product and hth household.
$\hat{b}_{0i}$ - The intercept term for the base profile for the ith product.
$\hat{b}_{1ih}$ - The effect of household income on the ith product of the hth household.
I_h - The average income of the hth household.
$\hat{b}_{2ih}$ - The effect of having a one person household on the ith product of the hth household
H_{1h} – The indication of household size of one person, for the hth household.
$\hat{b}_{3ih}$ - The effect of having a two people household on the ith product of the hth household.
H_{2h} – The indication of household size two people, for the hth household.

Figure 9. Mathematical representation of the OLS regression equations

$\hat{b}_{4ih}$ - The effect of having a two people household on the ith product of the hth household.
H_{3h} – The indication of household size of three people, for the hth household.
$\hat{b}_{5ih}$ - The effect of having a female household head less than 25 years old on the ith price of the hth household.
A_{1h} - The indication of a female household head less than 25 years old for the hth household.
$\hat{b}_{6ih}$ - The effect of having a female household head between than 40 and 64 years old on the ith price the hth household.
A_{2h} - The indication of a female household head between 40 and 64 years old for the hth household.
$\hat{b}_{7ih}$ - The effect of having a female household head 65 years old or older on the ith price of the hth household.
A_{3h} - The indication of a female household head 65 years old or older for the hth household.
$\hat{b}_{8ih}$ - The effect of having no children under 18 years old in the household on the ith price of the hth household.
C_h - The indication of having no children under 18 years old in the household for the hth household.
$\hat{b}_{9ih}$ - The effect of having female household head with a high school education or less on the ith price of the hth household
E_{1h} - The indication of having a female household head with a high school education or less for the hth household
$\hat{b}_{10ih}$ - The effect of having female household head with more than four years of college on the ith price of the hth household.
E_{2h} - The indication of having a female household head with more than four years of college for the hth household.
$\hat{b}_{11ih}$ - The effect of a household with a race other than white on the ith price of the hth household.
R_h - The indication of a household with a race other than white for the hth household.
$\hat{b}_{12ih}$ - The effect of the female household head having no employment on the ith price of the hth household.
J_{1h} - The indication of the female household head having no employment for the hth household.
$\hat{b}_{f13ih}$ - The effect of the female household head working less than 30 hours a week on the ith price of the hth household.
J_{2h} - The indication of the female household head working less than 30 hours a week for the hth household.
$\hat{b}_{14ih}$ - The effect of a non-Hispanic household on the ith price of the hth household.
S_h - The indication of a non-Hispanic household for the hth household.
$\hat{b}_{15ih}$ - The effect of the household located in the eastern region of th U.S. for the Ith price of the hth household.
R_{1ih}- The indication that the hth household is located in the eastern region of the U.S..

Figure 9. Continued.

$\hat{b}_{16ih}$ - The effect of the household located in the western region of th U.S. for the Ith price of the hth household.
R_{2ih} - The indication that the hth household is located in the western region of the U.S. .
$\hat{b}_{17ih}$ - The effect of the household living in the central region of th U.S. for the ith price of the hth household.
R_{3ih} - The indication that the hth household is located in the eastern region of the U.S. .
$\hat{b}_{18ih}$ - The effect of the household living outside a city for the Ith price of the hthhousehold..
NM_h – The indication of the hth households living outside a city.
e_{ih} – The unexplained error for the ith price of the hth household.

Figure 9. Continued.

All of the demographic variables in the regression model except household income are indicator variables. The estimated intercept term corresponds to the base demographic profile. In this case the base profile is that of a white Hispanic household with children under eighteen years of age, with a household size of more than four people, having a female head of house that has some college education, between the ages of twenty-five and forty, works more than 30 hours a week, and lives in the southern region of the U.S. in a city. Imputation for each price was made using the estimates from the regressions of only those households that purchased that brand of ice cream. The predicted prices were then imputed using the estimated coefficients. The predicted prices were used to fill in any missing values.

Model Selection

Four choices were considered for the type of demand system to be used. Three of the four choices are variations of the Almost Ideal Demand System specification, the

Linear Approximation of the Almost Ideal Demand System (LA/AIDS), the Almost Ideal Demand System (AIDS), itself, and what is referred to as the Quadratic Almost Ideal Demand System (QAIDS). The fourth choice considered was the trans-log specification of Christensen, Jorgenson, and Lau. Three of the four systems are non-linear systems.

The LA/AIDS model is well suited to cross-sectional data, and was a good candidate, however as mentioned previously the LA/AIDS model contains the Stone index that may result in biased estimates (Moschini). In light of this fact the LA/AIDS was excluded as the appropriate model. The AIDS model, which is non-linear and more complex in application then LA/AIDS, does not suffer from the Stone index biases dilemma and is well suited for cross-sectional data. Additionally, the AIDS has desirable properties when aggregating over consumers. The QAIDS model has the same advantages as the AIDS model with the additional allowance for non-linear Engel curves, which according to Banks, Blundell and Lewbel, may be supported by empirical evidence. However, it is considerably more complex to program given the additional burden of having to deal with censored observations. Both models were good candidates and were considered. However, the less complex AIDS model was the model chosen as to do this work. It should be noted that the QAIDS has merit as a valid system. The trans-log model also would have been a reasonable alternative of functional form, but was not used. To help clarify which model is being referred to, the regular AIDS model will be will be referred to as the NLAIDS, indicating that it is the non-linear version.

Although the primary model was the censored NLAIDS or CNLAIDS, several system models were estimated in order to help validate the usefulness of applying econometric theory and to provide reference points. The censored LA/AIDS (CLA/AIDS) was used to gauge differences in the compensated and uncompensated own-price and cross-price elasticities as well as expenditure elasticities versus estimating the CNLAIDS. The difference between the two system estimates can be attributed to approximation errors, errors due to linearizing, and/or the Stone index bias. Additionally, the NLAIDS model took into account the effects of using a censoring procedure. In the comparison of the censored verses non-censored models, complete matrices of elasticities and their associated p-values are provided. The results of these comparative models are found in Appendix F.

Estimation of the Models

The AIDS model as specified by Deaton and Muellbauer is of the PIGLOG class indicating that price is independent from expenditure in the log form.

(5-2) $w_{ih} = a_i + \sum_{j=1}^{13} g_{ij} \ln p_{jh} + b_i * \ln(x_h - P''_h) + e_{ih}$

Equation 5-2 General AIDS model specification.

i = 1,2,3,…,13 number of products

h = 1,2,3,……7195 number of households, observations where ω_{ih} = the budget share of the *i*th product of the *h*th household defined as

$$(5\text{-}3) \quad w_{ih} = \frac{p_{ih} * q_{ih}}{x_h}$$

Equation 5-3 Budget share equation.

where a_i was the constant coefficient in the share equation *i*, and γ_{ij} was the slope coefficient associated with good *j* in the *i* share equation .

Total expenditure for the *h*th household was defined as

$$(5\text{-}4) \quad x_h = \sum_{i=1}^{13} p_{ih} q_{ih}$$

Equation 5-4 Expenditure equation.

Up to this point the LA/AIDS, CLA/AIDS, NLAIDS and CNLAIDS models are identical. However, the LA/AIDS and CLA/AIDS use an index for an approximation of the effect of prices in the model. The most common index to use is the Stone index or approximation, which is only a function of the variables and renders the equation linear in parameters. Since the choice of the index is arbitrary and this system was estimated in levels, the Stone index was applied, as shown in equation (5-5a).

(5-5A) $$\ln P''_h = \sum_{k=1}^{13} w_{kh} \ln p_{kh}$$

Equation 5-5a The Stone approximation.

where p_{ih} was the price of good i for the hth household

The price index for the NLAIDS and CNLAIDS specification is defined in equation (5-5b) as.

(5-5b) $$\ln P''_h = a_0 + \sum_{k=1}^{13} a_k + \frac{1}{2} \sum_{k=1}^{13} \sum_{j=1}^{13} g_{kj} \ln p_k \ln p_j$$

Equation 5-5b Unaltered complete AIDS expenditure equation.

where k is a counter from 1,2,,,…..13.

The uncensored models automatically satisfy the adding-up restriction if the following conditions hold.

(5-6) $$\sum_{i=1}^{13} a_i = 1 \ , \sum_{i=1}^{13} g_{ij} = 0 \, , \ \sum_{i=1}^{13} b_i = 0$$

Equation 5-6 Conditions to ensure the adding-up restriction hold.

The restrictions for maintaining homogeneity are satisfied if and only if, for all i

(5-7) $\sum_{j=1}^{13} g_{ij} = 0$

Equation 5-7 Conditions to ensure that the homogeneity restriction is maintained.
and symmetry was satisfied if and only if

(5-8) $\gamma_{ij} = \gamma_{ji}$

Equation 5-8. Conditions to ensure that the symmetry restriction is maintained in AIDS model.

However, the censoring procedure adds additional variables to be estimated and modifications in the conditions must be made to impose these three classical conditions.

Censored-Correction Conditions

The method used to account for the censored observations was the one posed by Shonkwiler and Yen, who refer to it as the CTS. The CTS is an acronym for consistent two-step procedure.

The first stage of the CTS is known as the selection stage, which refers to the discrete choice where the dependent variable is a qualitative choice variable. In this case, the choice was to purchase or not to purchase the given product. This choice variable was assigned a value of (1) for having purchased the product during the year or (0) for not having purchased the product during the year. The choice variable was then modeled using a probit. The probit estimation process produces two important factors that carryover into the second stage of the CTS procedure: (1) the estimated cumulative distribution function (cdf) and (2) the probability distribution function, (pdf). Both are functions of the demographic variables. These carryover values represent the adjustment to the demand system necessary to account for the censored observations. With the imposition of the CTS, the model was then specified as

(5-9) $$w_{ih} = [a_i + \sum_{j=1}^{13} g_{ij} \ln p_{jh} + b_i * \ln(x_h - P''_h)] * c\hat{d}f_{ih} + j_i * p\hat{d}f_{ih} + e_{ih}$$

Equation 5-9 Censored AIDS model specification.

For both the CLA/AIDS and the CNLAIDS all the variables remain unchanged, as do the conditions for adding-up and homogeneity. However, a special condition must now be imposed to assure symmetry, to account for the multiplication of the *cdf* over each equation. The new condition was

(5-10) $cdf_i*\gamma_{ij} = cdf_j*\gamma_{ji}$ which implies $g_{ji} = \dfrac{cdf_{ih}}{cdf_{jh}} * g_{ij}$

Equation 5-10. The conditions to ensure that the symmetry restriction for the censored AIDS model hold.

Estimation of the Probit Model (Selection Stage)

The variables used in the probit model are not the same variables included in the demand model. The probit model was used to identify choice, and in this case households have already observed prices and made a choice about consumption.

Therefore, something other than price was used to explain their decision to consume. This reasoning was consistent with the budgeting process concept. Only demographic variables were used in this phase of the probit modeling process.

The right hand side (RHS) variables used in the probit model were income, household size, age, education, employment status of the female head of house, presence of children under eighteen years of age, race, region, and urban or non-urban dweller. In cases where the household had no female head, the indicators for the male head of house were used.

All of the RHS variables were indicator variables except income, which though not technically continuous, was treated as such. The incomes for households were reported within a range, therefore any given household in a specific range were assigned the average for that range. Summing the lowest and the highest boundaries of the range and dividing by two provided the averaged of each range. It should be noted that incomes less than $5,000.00 were averaged to $2,500, and for incomes over the $100,000 measure was set at $100,000.

Household size was classified into four groups: group1, single individual households (hs1); group 2, households of two individuals (hs2); group3, households with 3 individuals (hs3); and group 4, households with four or more individuals (hs4). Age of the female head of house was divided into four ranges: range 1, female heads less than twenty-five years of age (age25); range 2, female heads twenty-four to thirty-nine years of age (age40); range 3, female heads forty to sixty-five years of age (age50); and range 4, female heads over sixty-five years of age (age65). Households with children present under the age of eighteen years of age were coded as (child), and those households without children present under the age of eighteen years of age were coded as (child0). Female heads of house education level had three groups: group1, female heads with a high school or less education (edufh); group2, female heads of house with some college (edufsc); and group3, female heads with at least one degree (edufcp). Employment of the female heads also was separated into three groups: group1, female head not employed for pay (unemp); group2, female head of house employed but less than thirty-five hours per week (ptemp); and group3, female heads of house employed thirty-five or more hours per week (ftemp).

Households across the United States were classed in four general locations: area1, east; area2, west; area3, central; and area4, south. Households were identified as within an urban area (metro) or not (nonmetro). The dependent variable was a binary choice value of the i^{th} product, where a one (1) represents households that bought some of the i^{th} product, and zero (0) represents households where none of the i^{th} product was bought, where $i = 1,2,3,\ldots 13$. All of these conditions were imposed on the model. Only twelve equations were estimated with the thirteenth being imputed because of the restrictions imposed on the model. A complete summary of the probit results is found in the Appendix G.

The implementation of the CNLAIDS parallels that of the CLA/AIDS. The same two-step process was necessary to get cdf and pdf estimates and apply them to the uncensored models to get both the CLA/AIDS and the CNLAIDS. The probit for the CLA/AIDS and CNLAIDS was the same estimation of the same variables resulting in one set of cdf's and pdf's for both censored models. The cdf and pdf from the probit analysis, stage-one were saved and used in the next phase. The cdf was multiplied by the specific product *i*'s demand equation (equation (5-9)) and the pdf was weighted by a new parameter (f). Once the effect of censoring has been accounted for in the estimation process, providing the conditions of symmetry hold, the standard elasticity formulae may be applied.

Elasticity Estimates for the CLA/AIDS and LA/AIDS

The uncompensated elasticity equations for the CLA/AIDS model are the same the LA/AIDS as taken from Green and Alston version number iii. The E_{ij}*'s* are the uncompensated own-price and cross-price elasticities.

(5-11) $E_{ij} = -d_{ij} + (g_{ij} - b_i / w_j) / w_i$

Equation 5-11. The LA/AIDS model uncompensated elasticities formula.

where the Kronecker delta (δ) equal one when $i = j$.

The compensated elasticity, E_{ij}', incorporates the Slutsky relationship where the share weighted income effect was added to the compensated elasticity.

(5-12) $E_{ij}' = E_{ij} + w_j * h_i$

Equation 5-12. The LA/AIDS model compensated elasticities formula.

h_i was the expenditure elasticity of the i^{th} product where

(5-13) $h_i = (1 + b_i / w_i)$

Equation 5-13 The LA/AIDS model expenditure elasticities formula.

Elasticity Estimates for the CNLAIDS and NLAIDS

Since the NLAIDS was a non-linear model and the elasticities are defined using differentiation of the share equations, the NLAIDS elasticities are different for those of the LA/AIDS model for both uncompensated and compensated elasticities. However, the expenditure elasticities for the two models are identical, since the expenditure portions of the two equations are identical. The uncompensated own-price and cross-price elasticity equations for the CNLAIDS and NLAIDS are defined as:

(5-14) $x_{ij} = -d_{ij} + (g_{ij} - b_i * a_j - b_i * \sum_{k=1}^{13} g_{kj}) / w_{ii}$

Equation 5-14. Non-Linear AIDS model uncompensated elasticity formula.

Where the Kronecker delta (δ) equals one when $i = j$.

The compensated elasticity, ξ_{ij}', incorporates the Slutsky relationship where the share weighted income effect was added to the compensated elasticity.

(5-15) $x'_{ij} = x_{ij} + w_{ji} * N_i$

Equation 5-15. Non-Linear AIDS model uncompensated elasticity formula.

where N_i was the expenditure elasticity of the *i*th product, where

(5-16) $N_i = (1 + b_i / w_i)$

Equation 5-16. Non-Linear AIDS model formula for the expenditure elasticity.

Only three of the four models were estimated, CLA/AIDS, NLAIDS and CNLAIDS. The only elasticities reported in the main body of this chapter are from the CNLAIDS model. Three different kinds of elasticities are reported, own-price, cross-price and expenditure elasticities. Own-price and cross-price elasticities included both compensated and uncompensated. The elasticities for the CLA/AIDS and NLAIDS, as well as a comparison of all three models are in the Appendix F. The parameter estimates with the standard errors and t-statistics for the CNLAIDS model are in Appendix G. The matrices of uncompensated, compensated, and expenditure elasticities for the CNLAIDS model are in Tables 34, and 35.

Results: CNLAIDS Estimates

Because of the size of the model and the number of elasticities involved, only the censored corrected non-linear AIDS compensated elasticities are discussed in the remaining results. To further facilitate the task of assembling the results in a comprehensible manner, a series of comparisons were made. The first sets of comparisons were based on individual product verses all other products which could be considered an inter-product comparison. The comparisons rank the products and place them in order of effect, ranging from the largest substitutes to smallest complement. The effects are either net substitutes or net complements since they are compensated elasticities. The second sets of comparisons were done by product type, and are referred to as intra-product comparisons. The third set of comparisons were done by container size, this grouping was referred to as an intra-size grouping. The Final set of comparisons were done by comparing categories, such as all white milk with all fruit juices, this comparison was referred to as an intra-category comparison. In this last comparison the evaluation was based on significance and sign.

To help facilitate a more concise reporting of the results all references to the beverages henceforth will be in the form of acronyms. Acronyms for the thirteen beverage products will be fruit juices denoted as FJ with sizes of quart, Q, half-gallon, H, and gallon, G. Bottled water was BW with sizes of half-gallon or less, H, and G, more than a half-gallon. CSDs are in sizes of pint, P, quart, Q, and half-gallon, H. White milk denoted as WM with sizes of quart, Q, half-gallon, H, and gallon, G. Flavored Milk denoted as FM with sizes of quart, Q, half-gallon, H, and gallon, G. A reference table is provided that shows all of the beverages and their appropriate acronyms, Table 33. Table 34 shows the matrix of uncompensated elasticities from the estimation of the CNLAIDS model, with the last column being the expenditure elasticities. Table 35 shows the matrix of compensated elasticities from the same CNLAIDS model.

Table 33. Acronyms for Beverages Included in the Demand System

Container Size	Pint	Quart	Half-Gallon	Gallon
Beverage Type				
White Milk	-	WMQ	WMH	WMG
Flavored Milk		-	FMH	FMG
Carbonated Soft Drinks	CSDP	CSDQ	CSDH	-
Bottled Water	-	-	BWH	BWG
Fruit Juice	-	FJQ	FJH	FMG

Table 34. Uncompensated Elasticities of the CNLAIDS Model

Products	FJQ	FJH	FJG	BWH	BWG	CSDP	CSDQ	CSDH	Products	WMH	WMG	FMQ	FMH	N_i
FJQ	-1.5335	0.1262	-0.0465	0.0975	0.0212	0.3026	0.0769	0.0412	0.0393	0.3030	-0.2289	0.0007	-0.0022	0.8025
p-value	0.000	0.001	0.060	0.000	0.439	0.000	0.024	0.219	0.198	0.000	0.002	0.931	0.851	0.000
FJH	0.0407	-0.5189	0.0350	0.0229	0.0087	-0.0276	-0.0688	-0.0381	-0.1033	-0.0789	-0.2767	-0.0193	-0.0216	1.0460
p-value	0.013	0.000	0.010	0.054	0.554	0.271	0.000	0.057	0.000	0.001	0.000	0.003	0.014	0.000
FJG	-0.1215	0.0946	-0.6110	0.0037	-0.1904	0.0607	0.0913	-0.5314	0.1436	-0.0528	-0.1489	0.0086	-0.0573	1.3107
p-value	0.005	0.067	0.000	0.947	0.005	0.513	0.162	0.000	0.051	0.594	0.284	0.724	0.102	0.000
BWH	0.3614	0.2485	0.0415	-3.1251	-0.2405	1.0893	0.2660	-0.0739	0.1555	0.2936	0.1712	0.0730	0.1744	0.5650
p-value	0.000	0.006	0.711	0.000	0.113	0.000	0.056	0.577	0.323	0.177	0.561	0.117	0.010	0.000
BWG	0.1263	0.1707	-0.4316	-0.2849	-1.6054	0.4201	0.4128	0.2214	-0.0783	1.2387	-0.5268	-0.0830	-0.0099	0.4297
p-value	0.269	0.209	0.010	0.119	0.000	0.172	0.087	0.351	0.795	0.001	0.310	0.370	0.940	0.000
CSDP	0.0641	-0.0318	0.0153	0.0789	0.0184	-1.2102	0.1086	-0.0153	-0.0377	0.0036	-0.1271	-0.0003	-0.0060	1.1395
p-value	0.000	0.045	0.322	0.000	0.384	0.000	0.000	0.297	0.002	0.866	0.001	0.925	0.187	0.000
CSDQ	0.1413	-0.2444	0.1008	0.1336	0.1692	0.6922	-2.5128	-0.1739	0.0161	0.2037	0.5299	0.0273	0.0370	0.8801
p-value	0.017	0.000	0.127	0.055	0.091	0.000	0.000	0.010	0.801	0.061	0.001	0.133	0.175	0.000
CSDH	-0.0068	-0.0439	-0.1164	-0.0201	0.0101	-0.0128	-0.0463	-0.6090	-0.0277	-0.0513	-0.2054	0.0078	0.0050	1.1166
p-value	0.616	0.013	0.000	0.189	0.655	0.529	0.003	0.000	0.025	0.006	0.000	0.218	0.544	0.000
WMQ	0.6124	-0.7195	0.7569	0.3802	-0.0734	0.2725	0.1006	0.4331	0.8964	0.9154	0.4367	-0.1144	-0.1410	-3.7558
p-value	0.001	0.001	0.005	0.182	0.871	0.282	0.667	0.025	0.214	0.119	0.561	0.324	0.469	0.000
WMH	0.4005	-0.0611	0.0123	0.1083	0.3304	0.2246	0.1359	0.0224	0.1423	-2.0015	0.5410	0.0227	-0.0184	0.1408
p-value	0.000	0.272	0.847	0.119	0.001	0.005	0.052	0.666	0.177	0.000	0.006	0.229	0.528	0.000
WMG	-0.1227	-0.2620	-0.0350	0.0015	-0.0570	-0.2035	0.1001	-0.2247	-0.0284	0.1106	-0.5723	-0.0307	-0.0258	1.3498
p-value	0.000	0.000	0.223	0.961	0.194	0.000	0.003	0.000	0.506	0.082	0.000	0.241	0.577	0.000
FMQ	0.0246	-0.7935	0.1289	0.4164	-0.3989	0.0901	0.3111	0.4673	-0.4168	0.3587	-1.5898	2.7078	-1.9802	0.6742
p-value	0.875	0.006	0.652	0.114	0.369	0.589	0.137	0.126	0.299	0.251	0.272	0.026	0.104	0.000
FMH	-0.1996	-0.6701	-0.3686	0.6175	-0.1295	-0.0608	0.2510	0.2988	-0.8330	-0.7747	-0.4394	-1.4218	2.3078	1.4225
p-value	0.218	0.015	0.200	0.024	0.772	0.699	0.261	0.288	0.056	0.028	0.807	0.101	0.196	0.000

* See Table 33 for a complete explanation of the acronyms (Page 101)

Table 35. Compensated Elasticities of the CNLAIDS Model

Products	FJQ	FJH	FJG	BWH	BWG	CSDP	CSDQ	CSDH	WMQ	WMH	WMG	FMQ	FMH
FJQ	-1.4789	0.2452	-0.0152	0.1130	0.0340	0.4904	0.1080	0.1756	0.0478	0.3517	-0.0767	0.0034	0.0017
p-value	0.000	0.000	0.540	0.000	0.215	0.000	0.002	0.000	0.117	0.000	0.293	0.679	0.886
FJH	0.1118	-0.3637	0.0758	0.0432	0.0254	0.2171	-0.0284	0.1371	-0.0921	-0.0155	-0.0782	-0.0158	-0.0166
p-value	0.000	0.000	0.000	0.000	0.083	0.000	0.057	0.000	0.000	0.494	0.015	0.016	0.058
FJG	-0.0323	0.2891	-0.5598	0.0290	-0.1695	0.3673	0.1420	-0.3119	0.1575	0.0266	0.0998	0.0131	-0.0510
p-value	0.452	0.000	0.000	0.601	0.012	0.000	0.030	0.000	0.032	0.788	0.472	0.593	0.145
BWH	0.3999	0.3324	0.0636	-3.1142	-0.2315	1.2214	0.2878	0.0208	0.1615	0.3278	0.2784	0.0750	0.1771
p-value	0.000	0.000	0.571	0.000	0.127	0.000	0.039	0.875	0.305	0.132	0.344	0.107	0.009
BWG	0.1556	0.2345	-0.4148	-0.2766	-1.5986	0.5206	0.4294	0.2934	-0.0737	1.2648	-0.4452	-0.0815	-0.0078
p-value	0.175	0.084	0.013	0.131	0.000	0.090	0.075	0.216	0.807	0.001	0.391	0.379	0.952
CSDP	0.1416	0.1373	0.0598	0.1010	0.0365	-0.9437	0.1527	0.1755	-0.0255	0.0727	0.0891	0.0035	-0.0006
p-value	0.000	0.000	0.000	0.000	0.083	0.000	0.000	0.000	0.039	0.001	0.019	0.262	0.899
CSDQ	0.2012	-0.1138	0.1352	0.1506	0.1832	0.8980	-2.4788	-0.0265	0.0255	0.2571	0.6969	0.0303	0.0412
p-value	0.001	0.047	0.041	0.031	0.067	0.000	0.000	0.693	0.690	0.018	0.000	0.096	0.131
CSDH	0.0692	0.1218	-0.0728	0.0015	0.0279	0.2484	-0.0031	-0.4220	-0.0158	0.0164	0.0065	0.0116	0.0103
p-value	0.000	0.000	0.000	0.922	0.217	0.000	0.843	0.000	0.199	0.378	0.850	0.068	0.212
WMQ	0.3569	-1.2767	0.6103	0.3075	-0.1333	-0.6061	-0.0447	-0.1959	0.8563	0.6877	-0.2760	-0.1270	-0.1588
p-value	0.063	0.000	0.023	0.280	0.769	0.019	0.849	0.312	0.235	0.241	0.712	0.273	0.415
WMH	0.4101	-0.0402	0.0178	0.1111	0.3326	0.2575	0.1413	0.0459	0.1438	-1.9930	0.5677	0.0232	-0.0178
p-value	0.000	0.469	0.780	0.110	0.001	0.001	0.044	0.373	0.173	0.000	0.004	0.220	0.543
WMG	-0.0309	-0.0617	0.0177	0.0276	-0.0354	0.1123	0.1523	0.0014	-0.0140	0.1925	-0.3162	-0.0262	-0.0194
p-value	0.237	0.014	0.538	0.359	0.419	0.015	0.000	0.964	0.744	0.002	0.008	0.318	0.675
FMQ	0.0705	-0.6935	0.1553	0.4294	-0.3881	0.2478	0.3372	0.5802	-0.4097	0.3996	-1.4618	2.7101	-1.9770
p -value	0.651	0.017	0.587	0.103	0.382	0.156	0.107	0.058	0.307	0.197	0.313	0.026	0.104
FMH	-0.1029	-0.4591	-0.3131	0.6450	-0.1069	0.2720	0.3060	0.5371	-0.8178	-0.6885	-0.1694	-1.4170	2.3145
p-value	0.514	0.094	0.278	0.019	0.811	0.139	0.170	0.059	0.060	0.045	0.925	0.102	0.195

* See Table 33 for a complete explanation of the acronyms (Page 101).

Inter-product Comparisons

FJQ has an own-price elasticity of -1.4789 with statistically significant substitutes of CSDP with an cross-price elasticity of .4904, WMH at .3517, FJH at .2452, CSDH at .1756, BWH at .1130, and CSDQ at .1080. All other products were statistically insignificant.

FJH has an own-price elasticity of -.3637 with statistically significant substitutes of CSDP with a cross-price elasticity of .2171, CSDH at .1371, FJQ at .1118, FJG at .0758, BWH at .0432, and three complements WMQ at -.0921, WMG at -.0782, and FMQ at -.0158. All other products were statistically insignificant.

FJG has an own-price elasticity of -.5598 with statistically significant substitutes of CSDP with a cross-price elasticity of .3673, FJH at .2891, WMQ at .1575, CSDQ at .1420, and two complements CSDH at -.3119, BWG at -.1695. All other products were statistically insignificant.

BWH has an own-price elasticity of -3.1142 with statistically significant substitutes of CSDP with a cross-price elasticity of 1.2214, FJQ at .3999, FGH at .3324, CSDQ at .2878, FMH at .1771, and no complements. All other products were statistically insignificant.

BWG has an own-price elasticity of –1.5986 with one statistically significant substitute, WMH with a cross-price elasticity of 1.2648 and one complement, FJG of -.4148. All other products were statistically insignificant.

CSDP has an own-price elasticity of -.9437 with statistically significant substitutes of CSDG with a cross-price elasticity of .1755, CSDQ at .1527, FJQ at .1416, FJH at .1373, BWH at .1010, WMG at .0891, WMH at .0727, FJG at .0598 and one complement WMQ at -.0255. All other products were statistically insignificant.

CSDQ has an own-price elasticity of -2.4788 with statistically significant substitutes of CSDP with a cross-price elasticity of .8980, WMG at .6969, WMH at .2571, FJQ at .2012, BWG at .1506, FJG at .1352, and one complement FJH at -.1138. All other products were statistically insignificant.

CSDH has an own-price elasticity of -.4220 with statistically significant substitutes of CSDP with a cross-price elasticity of .2484, FJH at .1218, FJQ at .0692, and one complement FJG at -.0728. All other products were statistically insignificant.

WMQ has an own-price elasticity of +.8563, which was not statistically significant, with a statistically significant substitute of FJG with a cross-price elasticity of .6103, and two complements FJH at -1.2767, CSDP at -.6061. All other products were statistically insignificant.

WMH has an own-price elasticity of -1.9930, with statistically significant substitutes of WMG with a cross-price elasticity of .5667, FGQ at .4101, BWG at .3326, CSDP at .2575, CSDQ at .1413 and no complements. All other products were statistically insignificant.

WMG has an own-price elasticity of -.3162, with statistically significant substitutes of WMH with a cross-price elasticity of .1925, CSDQ at .1523, CSDP at

.1123, and one complement, FJG at -.0617. All other products were statistically insignificant.

FMQ has an own-price elasticity of +2.7101, which was statistically significant, with one significant complement FJH at -.6935. All other products were statistically insignificant.

FMH has an own-price elasticity of +2.3145, which was not statistically significant, with a statistically significant substitute BWH with a cross-price elasticity of .6450, and one complement WMH at -.6885. All other products were statistically insignificant.

Inter-Product Comparison Summary

CSDP substituted for eight of the other twelve beverages, being the greatest substitute in six out eight times. CSDQ and FJQ were tied being substitutes six times each. Of the three times FJG and CSDQ were both substitutes of the same beverage; FJG was larger in magnitude twice. FJH and WMH were tied being substitutes five times each and only twice for the same beverage, each being ranked higher once. CSDH, FJG, and BWH were all tied being substitutes three times each and twice for the same beverage, CSDH was ranked higher in both cases, while FJG and BWH were split in ranking. BWG was a substitute twice. FMH was a substitute once and FMQ was never a substitute. Two products, WMQ and FMQ, had no substitutes. In all cases, except one, WMG and WMQ, the frequency of substitution was greater for the smaller product in the same product group.

Of the thirteen products only seven were complements, with four products FJQ, BWH, WMH, and FMH having no complements. FJH was complementary most frequently, and complementary four times. FJG and WMQ were complements twice each. BWG, CSDP, CSDH, and WMG were all complementary once. Six of the thirteen beverages were not complements, FJQ, CSDQ, BWH, WMH, FMQ, and FMH. All gallon measures were complements.

Intra-product Comparison

In the fruit juices group FJH was least affected by price with the smallest own-price elasticity of -.3637. FHQ was the most affected with an elasticity of -1.4789 while FJG was closer to FJH with an elasticity of -.5598. In the intermediate size, FJH was a substitute for either FJG or FJQ with cross-price elasticities of .0758 and .1118, respectively. FJQ did not have a statistically significant price relationship with FJG but FJH was a substitute with a cross-price elasticity of .2452. Similarly FJG did not have a statistically significant price relationship with FJQ, but FJH was a substitute with a cross-price elasticity of .2891 (see Table 36).

In the bottled water group BWG was least affected by price with the smallest own-price elasticity of –1.5986. BWH was most affected being elastic with an elasticity of -3.1142. Either BWG or BWH, have a statistically significant cross-price relationship (see Table 37).

Table 36. Intra-Product Compensated Elasticity Comparison of Fruit Juices for the CNLAIDS Model

Products	FJQ	FJH	FJG
FJQ	-1.4789	0.2452	-0.0152
p-value	0.000	0.000	0.540
FJH	0.1118	-0.3637	0.0758
p-value	0.000	0.000	0.000
FJG	-0.0323	0.2891	-0.5598
p-value	0.452	0.000	0.000

* See Table 33 for a complete explanation of the acronyms (Page 100).

Table 37. Intra-Product Compensated Elasticity Comparison of Bottled Water for the CNLAIDS Model

Products	BWH	BWG
BWH	-3.1142	-0.2315
p-value	0.000	0.127
BWG	-0.2766	-1.5986
p-value	0.131	0.000

* See Table 33 for a complete explanation of the acronyms (Page 100).

In the CSD group, CSDH was least affected by price with the smallest own-price elasticity of -4220. CSDQ was the most affected being very elastic with an elasticity of -2.4788 while CSDP was almost unit elastic with an elasticity of -.9437. CSDQ was the one size that was substituted for and was substitute by the other two sizes. This seems plausible when you consider that cans of soda close to this size are sold by the six-pack, a seventy-two ounce size. CSDQ substituted for either CSDH or CSDQ with cross-price elasticities of .2484 and .8980, respectively. CSDP was substituted by CSDH with a cross-price elasticity of .1755 and for CSDQ with a cross-price elasticity of .1527. CSDH and CSDQ did not have a statistically significant price relationship with each other (see Table 38).

Table 38. Intra-Product Compensated Elasticity Comparison of Carbonated Soft Drinks for the CNLAIDS Model

Products	CSDP	CSDQ	CSDH
CSDP	-0.9437	0.1527	0.1755
p-value	0.000	0.000	0.000
CSDQ	0.8980	-2.4788	-0.0265
p-value	0.000	0.000	0.693
CSDH	0.2484	-0.0031	-0.4220
p-value	0.000	0.843	0.000

* See Table 33 for a complete explanation of the acronyms (Page 100).

In the white milk group WHG was least affected by price with the smallest own-price elasticity of -.3162. WMH was the most affected being elastic with an elasticity of -1.9930 while WMQ had a positive and statistically insignificant own-price elasticity of .8563. Additionally, the smallest size WMQ had no other statistical relationship with either WMH, or WMG. WMH was a substitute for WMG with a cross-price elasticity of

.1925 and WMG was a substitute for WMH with a cross-price elasticity of .5667 (see Table 39).

In the flavored milk group, FHQ had positive own-price elasticity of 2.7101, which was statistically significant, however there may be some doubt of its value due to the small size of the budget share and its effect on the estimated coefficients.

Table 39. Intra-Product Compensated Elasticity Comparison of White Milk for the CNLAIDS Model

Products	WMQ	WMH	WMG
WMQ	0.8563	0.6877	-0.2760
p-value	0.235	0.241	0.712
WMH	0.1438	-1.9930	0.5677
p-value	0.173	0.000	0.004
WMG	-0.0140	0.1925	-0.3162
p-value	0.744	0.002	0.008

* See Table 33 for a complete explanation of the acronyms (Page 100).

This fact was true for FMH as well. Neither, FMQ nor FMH have a statistically significant cross-price effect on the other. It was interesting to note however that if the effects were significant they would be complements (see Table 40).

Intra-product Comparison Summary

The WM and FJ groups both had cross-price elasticities between the quart and gallon sizes, which were not statistically significant. However, the half-gallon or adjacent sized cross-price elasticities were positive and statistically significant with both quarts and gallons, making them substitutes.

Table 40. Intra-Product Compensated Elasticity Comparison of Flavored Milk for the CNLAIDS Model

Products	FMQ	FMH
FMQ	2.7101	-1.9770
p-value	0.026	0.104
FMH	-1.4170	2.3145
p-value	0.102	0.195

* See Table 33 for a complete explanation of the acronyms (Page 100).

The FJ group was the only group that had a statistically significant intra-group complement. FJQ was complementary with FJH, however, it was very small in value. The CSD group had all sizes as statistically significant substitutes, except between quarts and half-gallon sizes, and half-gallons and quarts sizes. The BW and FM groups had no statistically significant intra-group substitutes or complements.

Intra-size Results

In the quart size group, WMQ and FMQ had positive own-price elasticities, with only FMQ's being statistically significant. Additionally, WMQ and FMQ had no other significant cross-price elasticities with any other quart-size commodity. WMQ did have a complementary relationship with CSDP, a smaller size, of -.6061. The other quart size products, FJQ and CSDQ both had own-price elasticities greater than one, indicating a high degree of price sensitivity. CSDQ and FJQ were substitutes for each other. CSDQ was substituted for FJQ with a cross-price elasticity of .1080, and substituted by FHQ with a cross-price elasticity of .2012. Table 41 shows a summary of all the elasticities in this group.

Table 41. Intra-size Compensated Elasticity Comparison for the Quart Size Fruit Juices for the CNLAIDS Model

Products	FJQ	CSDQ	WMQ	FMQ
FJQ	-1.4789	0.1080	0.0478	0.0034
p-value	0.000	0.002	0.117	0.679
CSDQ	0.2012	-2.4788	0.0255	0.0303
p-value	0.001	0.000	0.690	0.096
WMQ	0.3569	-0.0447	0.8563	-0.1270
p-value	0.063	0.849	0.235	0.273
FMQ	0.0705	0.3372	-0.4097	2.7101
p-value	0.651	0.107	0.307	0.026

* See Table 33 for a complete explanation of the acronyms (Page 100).

The half-gallon intra-size was the only size group that contained all five types of beverages. FMH had a large positive and statistically insignificant own-price elasticity. BWH had the largest significant own-price elasticity of – 3.1142 followed by WMH with a –1.9930 own-price elasticity. CSDH and FJH were both fairly inelastic with own-price elasticities of -.4220 and -.3637 respectively. FMH had a complementary relationship with WMH with a cross-price of elasticity of -.6885 and was substituted by BWH with a cross-price elasticity of .6450. WMH had no significant cross-price elasticities in the intra-size group. CSDH was substituted by FJH with an elasticity of .1218. FJH was substituted by BWH and CSDH, with CSDH at .1371 being greater than BWH at .0432. BWH has by two product substitutes in the half-gallon intra-size group, WMH and FJH. Both WMH and FJH were nearly of the same magnitude with a cross-price elasticity of .3324 for FJH and .3278 for WMH. Although BWH and FJH were substituted for each other FJH was a much stronger substitute than BWH. In the case of WMH , BWH was not a substitute making that relationship completely asymmetrical. Table 42 exhibits a complete summary of the elasticities.

Table 42. Intra-size Compensated Elasticity Comparison for the Half-Gallon Size for the CNLAIDS Model

Products	FJH	BWH	CSDH	WMH	FMH
FJH	-0.3637	0.0432	0.1371	-0.0155	-0.0166
p-value	0.000	0.000	0.000	0.494	0.058
BWH	0.3324	-3.1142	0.0208	0.3278	0.1771
p-value	0.047	0.031	0.693	0.018	0.131
CSDH	0.1218	0.0015	-0.4220	0.0164	0.0103
p-value	0.000	0.922	0.000	0.378	0.212
WMH	-0.0402	0.1111	0.0459	-1.9930	-0.0178
p-value	0.469	0.110	0.373	0.000	0.543
FMH	-0.4591	0.6450	0.5371	-0.6885	2.3145
p-value	0.094	0.019	0.059	0.045	0.195

* See Table 33 for a complete explanation of the acronyms (Page 100).

The gallon size intra-size group had three types of products, BWG with an own-price elasticity of –1.5986, FJG with an own-price elasticity of -.5598, and WMG with an own-price elasticity of -.3162, and all were statistically significant. BWG was relatively elastic and FJG and WMG were relatively inelastic. WMG did not have a statistically significant relationship with either of the two other products in the intra-size grouping. BWG and FJG have a complementary relationship with each other. An increase in BWG price would reduce FJH quantity, with a cross-price elasticity of -.4148, and a price increase in FJG causes a reduction in BWG quantity, with a cross-price elasticity of -.1695. All of these relationships are summarized in Table 43.

Table 43. Intra-Size Compensated Elasticity Comparison of the Gallon Size for the CNLAIDS Model

Products	FJG	BWG	WMG
FJG	-0.5598	-0.1695	0.0998
p-value	0.000	0.012	0.472
BWG	-0.4148	-1.5986	-0.4452
p-value	0.013	0.000	0.391
WMG	0.0177	-0.0354	-0.3162
p-value	0.538	0.419	0.008

* See Table 33 for a complete explanation of the acronyms (Page 100).

Intra-size Results Summary

The intra-size cross-price relationships between CSDQ and FJQ were the only positive elasticities, substitutes, which were statistically significant for the quart size. The half-gallon size had the same positive significant relationships between product types as the quart size with the addition that FJH was a substitute for BWH. However, the magnitude of the BWH and FJH cross-price effect compared to the other cross-price elasticities was much smaller. The gallon size intra-size group had no substitution effects between product types; however, FJG and BWG were statistically significant complements of each other.

Intra-category Results

The product categories FJ and CSD had a total of 17 of the 18 possible cross-price elasticities. Fourteen of the cross-price elasticities were positive, indicating a substitutive relationship and the remaining 3 elasticities were complementary in effect.

The product categories FJ and BW had a total of 6 of the 12 possible cross-price elasticities. Four of the cross-price elasticities were positive indicating a substitutive relationship and the remaining 2 elasticities were complementary in effect.

The product categories FJ and WM had a total of 8 of the 18 possible cross-price elasticities. Four of the cross-price elasticities were positive indicating a substitutive relationship and the remaining 4 elasticities were complementary in effect.

The product categories FJ and FM had a total of 2 of the 12 possible cross-price elasticities. None of the cross-price elasticities were positive indicating a substitutive relationship and two elasticities were complementary in effect.

The product categories BW and CSD had a total of 4 of the 12 possible cross-price elasticities, none of the cross-price elasticities were positive indicating a substitutive relationship, and the remaining 3 elasticities were complementary in effect.

The product categories BW and WM have a total of 2 of the 12 possible cross-price elasticities. Two of the cross-price elasticities were positive indicating a substitutive relationship and no elasticities were representative of complementary effects.

The product categories BW and FM had a total of 2 of the 8 possible cross-price elasticities. Two of the cross-price elasticities were positive indicating a substitutive relationship and no elasticities were representative of complementary effects.

The product categories CSD and WM had a total of 10 of the 18 possible cross-price elasticities. Eight of the cross-price elasticities were positive indicating a substitutive relationship; the remaining 2 elasticities were complementary in effect.

The product categories CSD and FM had a total 0 of the 12 possible cross-price elasticities.

The product categories WM and FM had 0 of the 12 possible cross-price elasticities.

FJ had the most numerous significant effects with 33 of the 60 possible being significant, or 55%. CSD had the next most number of significant cross-price elasticities with 31 of 60, or 51.67%. WM was ranked third with 20 out of 60 for 33.33% of the cross-price elasticities being statistically significant. BW only had a significant cross-price elasticity rate of 14 of 44, or 31.82%. The lowest ranked cross-price elasticity rate was for FM, which had only 4 of the 44 possible cross-price elasticities as statistically significant, a rate of 9.09%.

General Points

Overall the single product that had the most numerous cross-price effects was CSDP. It was evident that FJ and CSD categories had the most frequent substitutions between product categories. Of the groups that had complementary relationships, the categories, which were most frequently complementary, were FJ and WM. The cross-price elasticity for FJH as a complement for WMQ was -1.2767, much higher then either of the own-price effects, and the smallest, most effective of the negative cross-price elasticities. FJH was involved in fifty percent of all the statistically significant complementary relationships. In fact, 11 of the 14 statistically significant, negative cross-price elasticities involve a juice, either FJH or FJG. The BW category own-price elasticities are both less than negative one, and greater than one in absolute value, making his category the most overall elastic category.

Conclusions and Discussion

Nonalcoholic beverages sold in different sized containers had very different elasticities. BWH own-price elasticity is nearly twice the magnitude of the BWG. WMG was inelastic while WMH was very elastic. Cross-price effects also were very different. For example, it was shown that FJH was a net complement for WMQ, while FJG was a net substitute for WMQ. If the commodities had been aggregated into a single system the outcome would probably have been much different.

Concerns with those elasticities estimated with small budget shares, such as with the WMQ, FMQ, and FMH, need further investigation. Some of the own-price elasticities were positive and/or insignificant. Variation between estimates of the small budget shared commodities was great when different regimes were specified for the demand system.

Appendix F shows the outcome of three different estimation procedures. A simple comparison of the own-price and expenditure elasticities, as found in this appendix shows how the model specification makes a difference for some of the elasticities, including those with a small budget share. The censored model results were quite different then the uncensored and the results from the linearly approximated model was different than the nonlinear model. It should be noted that an extension of this work might include the use of other alternative systems models, such as the Quadratic AIDS model and the Trans-log model.

Some concerns developed during the model estimation, which are always present when using any nonlinear estimation procedure. A change in the starting values sometimes affected the estimation outcome. It was possible that the outcomes reported may not correspond to the global maximization of the log likelihood function, implying that the estimated coefficients and, thus, the elasticity estimates might not be correct. In effect one set of problems associated with the LA/AIDS model were exchanged for another set of problems associated with nonlinear estimation.

Although these concerns affected the strength of our results, the outcome showed progress toward a better understanding of the interrelationships of beverages in the at-home non-alcoholic beverage market. For the first time, beverage size for each of the modeled products was considered in sizes consistent with available products. The disaggregation by container size of the products within the demand system provided a more detailed picture of the market place. The disaggregation was made possible by the use of scanner data. Given the extra information in scanner data it made sense to use it. Perhaps this was what Capps and Love envisioned when they predicted that scanner data would lead to an enhanced understanding of consumer behavior regarding food and beverage products.

CHAPTER VI

SUMMARY AND DISCUSSION

Chapter III Summary

The LA/AIDS model was used to estimate elasticities in San Antonio for leading brands ice cream. The elasticities were then used in the Capps, Church and Love methodology of determine if a set of simulated mergers would cause any statistically significant price increases. Although no significant price changes were found, the inventory effect usually found in this type of analysis was accounted for by use of cross-sectional data.

The effect inventory has on the size of own-price and cross-price elasticities have been a concern for those who use NEIO analysis to evaluate proposed mergers. The use of HSD data was shown to provide away to address this problem by allowing the creation of a cross-sectional data set. Ideally a comparison of the cross-sectional methodology and the time-series methodology using the same data set would go a long way to identifying the actual inventory effects that might exist. Unfortunately this comparison was not possible using the HSD data set.

Because of the nature of the HSD data set a certain amount of information was unavailable. Further work needs to be done to account for the censoring that was found in the cross-sectional data set. Shonkwiler and Yen's CTS method of censoring was attempted, but the results seemed unrealistic, and therefore were not applied to the final model. Different methods of censoring may have a different effect and therefore need to be investigated. In addition to the censoring problem, the budget shares from some of the brands were very small which may also have contributed to the inconsistent results from censoring.

In most cases NEIO studies are done using the Linear Approximation of the AIDS model. However, since the elasticity estimates of the demand system are used in the CCL methodology to determine price changes, robustness of the estimates could be determined by using other model specifications, such as the Non-Linear and Quadratic AIDS models and the Translog demand system. Additionally there are theoretical advantages to using some of these other model specifications, such as perfect aggregation in the Non-Linear AIDS, and specification of income effect that are quadratic, available in the Quadratic AIDS.

Chapter IV Summary

Considering the identification problems associated with doing hedonic price estimation, hedonic prices were estimated for three different container sizes and five characteristics, using a quantity dependent hedonic model (Nerlove). Transactional data were used in the hedonic price estimation. The interpretation of the hedonic prices estimated in the Nerlove model is consistent with the demand theory concept of willingness to pay versus the price dependent system, which represents a marginal implicit price valuation of characteristics. The fat types, brand type, and container type are different in effect depending on container size.

This works supports Nerlove's contention that one must be careful when estimating a hedonic model, since incorrect application of methodology will result in very different estimates which have very different interpretation.

Chapter V Summary

Container sizes generally have been an interesting question for manufacture's, retailers and consumers. Until now this issue has been neglected in demand system analysis. By estimating a system that included various container sizes, much different and unique elasticity were estimated.

Elasticities representing intra-product price quantity relationships provide insight into the difference that package size has on a single product. Inter-product elasticities also were enlightening, since a comparison of elasticities of different sizes of one product with respect to a single size and type of another product were compared, and found to be different. Products, which are normally considered to be substitutes for one another, were found to be complementary for some sizes and substitutes for others.

The model estimated was a censored corrected non-linear AIDS model. The presence of small budget shares, and/or a high degree of censoring radically affected elasticity estimates. Since the estimates were derived using a non-linear estimation method, typical non-linear estimation issues are a concern, such as stability of the parameter estimates with respect it different starting values.

To help to fortify the robustness of the result several things should be pursued. A series of models using other censoring methods and other demand system specifications could be implemented. Other demand systems could include the Translog model and the quadratic AIDS model. Additionally the same study could be repeated using similar data from other years. It also may be informative to compare these elasticity results of those obtained using weekly scan data.

Discussion

It has been shown that HSD data are quite useful in addressing economic problems. HSD data provides information not available in other data sets, such as demographic profiles and individual transaction information. The characteristics of the data make it possible to apply economic theory in a disaggregate way. Carefully designed models either as a demand system, hedonic price model, or some other detailed economic model can be estimated using this data, which can provide detailed information either in product space, or geographic space.

These carefully constructed models can be tailored to answer very specific questions. The questions addressed in this paper are a very small sample of limitless possibilities. Although the number of possibilities and applications are limitless the realm in which those applications are correctly applied is finite. The goal of the applied economist is to use theory and empirical information to solve a problem or answer a specific question.

Since the HSD is an innovation in data, it is yet unclear how to completely capitalize on that innovation to answer economic question. The contribution of this work is in recognition of this fact and the recognition that this work itself needs work. The HSD data are well suited to estimating hedonic models, since each product has detailed information about it. The unfortunate thing about these data is the censoring that occurs in the demand system analysis. Although a method is used to adjust for censored observations, problems about the adjustment still remain. As with any good research, the questions raised by the work provide the fuel for further investigations.

REFERENCES

ACNielsen From the corporate home page "Homescan Consumer Panel". Available at http://www.acnielsen.com/products/reports/homescan/consumerpanel/. Accessed: September 2004.

Asatryan A. A. "Data Mining of Market Information to Assess At-Home Pork Demand." PhD dissertation, Department of Agricultural Economics, Texas A&M University, College Station, 2003.

Banks, J., R. Blundell, and A. Lewbel. "Quadratic Engel Curves and Consumer Demand." *Review of Economics and Statistics* 79(1997):527-539.

Brendt, E. R. *The Practice of Econometrics: Classic and Contemporary*. Addison-Wesley, 1991.

Bucklin R. E., and S. Gupta. "Commercial Use of UPC Scanner Data: Industry and Academic Perspectives." *Marketing Science* 18:3(1999):274-300.

Capps, O., Jr. "A Literature Review of Research Related to Own-Price Elasticity of Demand for Fluid Milk Products in the United States." Report presented to the International Dairy Foods Association, Texas A&M University Agricultural Economics Department, March 2003.

Capps, O., Jr., and A. Love. "Econometric Considerations in the Use of Electronic Scanner Data to Conduct Consumer Demand Analysis." *American Journal of Agricultural Economics* 84(2002):807-816.

Capps, O., Jr., J. Church, and A. Love. "Specification Issues and Confidence Intervals in Unilateral Price Effects Analysis." *Journal of Econometrics* 113(2003):3-31.

Capps, O., Jr., and R. Nayga, Jr. "Effect of Length of Time on Measured Demand Elasticities: The Problem Revisited." *Canadian Journal of Agricultural Economics* 38(1990):499-512.

Changwon, P., and B. Senauer. "Estimation of Household Brand-size Choice Models for Spaghetti Products with Scanner Data." Working Paper 96-01, Retail Food Industry Center, Department of Applied Economics, University of Minnesota, Minneapolis, 1996.

Deaton, A., and J. Muelbauer. "An Almost Ideal Demand System." *American Economic Review* 70(1980):312-326.

Feiveson, A. H. “Explanation of the Delta Method.” Available at http://www.stata.com/support/faqs/stat/deltam.html. Accessed: September 2004.

Glaser, L. C., and G. D. Thompson. “Demand for Fluid Milk Products in the Northeast.” AERS Staff Paper No. 83-14, University of Connecticut, Storrs, Connecticut, August 1983.

Goodman, A. C. “Hedonic Prices Revisited, Yet Again: Andrew Court’s Work.” Unpublished, Economics Department, Wayne State University, Detroit, 1997.

Gould, B. W., T. L. Cox, and F. Perali. “Demand for Fluid Milk Products in the U. S.: Demand Systems Approach.” *Western Journal of Agricultural and Resource Economics* 15(1990):1-12.

Green, R., and J. M. Alston. “Elasticities of the AIDS Models.” *American Journal of Agricultural Economics* 72(1990):442-445.

Heien, D., and C. R. Wessells. “Demand Systems Estimation with Microdata: A Censored Regression Approach.” *Journal of Business and Economic Statistics* 8(1990):365-371.

Hosken, D., D. O’Brien, D. Scheffman, and M. Vita. “Demand System and Its Application to Horizontal Merger Analysis.” Forthcoming paper in “The Use of Econometrics in Antitrust,” American Bar Association Section on Antitrust, J. Harkrider, ed.(2002), Available at http://www.ftc.gov/be/workpapers/wp246.pdf

Jordan J. L., R. L. Shewfelt, S. E. Prussia, and W. C. Hurst. “Estimating Implicit Marginal Prices of Quality Characteristics of Tomatoes.” *Southern Journal of Agricultural Economics* 17(1985):139-146.

Kinoshita J., S. Nobuhiro, T. Kawamura, Y. Watanabe, and H. M. Kaiser. “Estimating Own and Cross Brand Price Elasticities, and Price-Cost Margin Ratios Using Store-Level Daily Scanner Data.” *Agribusiness* 17(2001):515-525.

Kuh. E., and J. R., Meyer. “How Extraneous are Extraneous Estimates?” *Review of Economics and Statistics* 39(1957):380-393.

Lattin, J. M., and R. E. Bucklin. “The Dynamics of Consumer Response to Price Discounts.” Research Paper 963, Stanford Graduate School of Business, 1987. Available at http://gobi.stanford.edu/researchpapers/detail1.asp?Document_ID=749: Accessed September, 2004.

Mann, B, "Nestle's Frozen Merger" Motley Fool. Available at http://www.fool.com/Server/FoolPrint.asp?File=/news/take/2003/mft/mft03030501.ht: Accessed September, 2004.

Moschini, G. "Units of Measure and the Stone Index in Demand System Estimation." *American Journal of Agricultural Economics* 77(1995):63-68.

Nayga, R. M. "Scanner Data in Supermarkets: Untapped Data Source for Agricultural Economists." *Review of Marketing and Agricultural Economics* 60(1992):205-212.

Nerlove, M. "Hedonic Price Functions and Measurement of Preferences: The Case of Swedish Wine Consumers." *European Economic Review* 39(1995):1697-1716.

Nyman, R. A., and O. Capps Jr. "A Perspective on the Demand for Fluid and Manufactured Dairy Products from 1970 to 1999." Department of Agricultural Economics Technical Report 03-01, Texas A&M University, College Station, October 2002.

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82(1974):34-55.

Rojoko, A. S. "Econometric Models for the Dairy Industry." *Journal of Farm Economics* 39(1957):323-338.

Schmit, T. M., C. Chung, D. Dong, H. M. Kaiser, and B. Gould. "Identifying the Extensive and Intensive Effects of Generic Advertising on the Household Demand for Fluid Milk and Cheese." National Institute for Commodity Promotion Research and Evaluation, Department of Applied Economics and Management and College of Agriculture and Life Sciences, Cornell University, Ithaca, New York, January 2001.

Shonkwiler, S., and S. Yen. "Two-step Estimation of a Censored System of Equations." *American Journal of Agricultural Economics* 81(1999):972-982.

Waugh, F. V. "Quality Factors Influencing Vegetable Prices." Paper presented at 18th Annual Meeting of the American Farm Economics Association, Washington D. C., December 1927.

Working, E. J. "What Do Statistical 'Demand Curves' Show?" *Quarterly Journal of Economics* 41(1927):212-235.

Yen, S. T., B. Lin, and D. M. Smallwood. "Quasi- and Simulated-Likelihood Approaches to Censored Demand Systems: Food Consumption by Food Stamp Recipients in the United States." *American Journal of Agricultural Economics* 85(2003):458-478.

Supplemental Sources Consulted

Capps, O., Jr., G. Pittman, and R. Nyman. "Have Milk Preferences Shifted? Structural Analysis of New York Milk Consumption: Comment." Unpublished Report, Texas A&M University, College Station, 2002.

Herrmann, R., and C. Roeder. "Some Neglected Issues in Food Demand Analysis: Retail-Level Demand, Health Information and Product Quality." *Australian Journal of Agricultural and Resource Economics* 42:4(1998):341-367.

Maynard, L. J., and D. Liu. " Fragility in Dairy Product Demand Analysis." Selected Paper, American Agricultural Economics Association Annual Meetings, Nashville, TN, August, 1999.

APPENDIX A

PRICE IMPUTATION COEFFICIENTS FOR CHAPTER III

Table A1. Price Imputation Coefficients for Brand One

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
β_1	0.000	0.00	-0.63	0.53
β_2	0.271	0.27	1.02	0.31
β_3	-0.044	0.21	-0.20	0.84
β_4	0.052	0.18	0.30	0.77
β_5	0.184	0.16	1.16	0.25
β_6	-0.140	0.16	-0.89	0.37
β_7	-0.287	0.21	-1.38	0.17
β_8	0.147	0.21	0.70	0.49
β_9	0.162	0.14	1.13	0.26
β_{10}	0.080	0.14	0.57	0.57
β_{11}	0.155	0.16	0.94	0.35
β_{12}	0.267	0.14	1.86	0.06
β_{13}	0.278	0.17	1.63	0.10
β_{14}	0.053	0.16	0.32	0.75
β_0	4.040	0.27	15.06	0.00

See Figure 2, page 26, for variables definitions.

Table A2. Price Imputation Coefficients for Brand Two

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
β_1	0.000	0.00	3.22	0.00
β_2	0.685	0.26	2.65	0.01
β_3	0.453	0.20	2.28	0.02
β_4	0.238	0.16	1.52	0.13
β_5	-0.097	0.14	-0.69	0.49
β_6	-0.228	0.14	-1.64	0.10
β_7	-0.168	0.19	-0.88	0.38
β_8	-0.107	0.19	-0.56	0.57
β_9	0.105	0.12	0.86	0.39
β_{10}	0.003	0.13	0.03	0.98
β_{11}	0.214	0.14	1.48	0.14
β_{12}	-0.155	0.12	-1.25	0.21
β_{13}	0.143	0.15	0.98	0.33
β_{14}	0.163	0.14	1.19	0.24
β_0	2.313	0.22	10.35	0.00

See Figure 2, page 26, for variables definitions.

Table A3. Price Imputation Coefficients for Brand Three

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
$ß_1$	0.000	0.00	-1.11	0.28
$ß_2$	-0.257	0.79	-0.32	0.75
$ß_3$	-0.747	0.59	-1.27	0.22
$ß_4$	-0.068	0.65	-0.11	0.92
$ß_5$	0.684	0.87	0.79	0.44
$ß_6$	0.225	0.44	0.51	0.61
$ß_7$	-0.742	0.76	-0.97	0.34
$ß_8$	0.118	0.74	0.16	0.87
$ß_9$	-0.082	0.41	-0.20	0.84
$ß_{10}$	0.049	0.36	0.13	0.89
$ß_{11}$	0.584	0.72	0.82	0.42
$ß_{12}$	0.190	0.38	0.49	0.63
$ß_{13}$	0.505	0.48	1.05	0.30
$ß_{14}$	0.007	0.53	0.01	0.99
$ß_0$	4.162	0.92	4.53	0.00

See Figure 2, page 26, for variables definitions.

Table A4. Price Imputation Coefficients for Brand Four

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
$ß_1$	0.000	0.00	-0.53	0.60
$ß_2$	0.078	0.53	0.15	0.88
$ß_3$	-0.157	0.45	-0.35	0.73
$ß_4$	0.015	0.39	0.04	0.97
$ß_5$	0.074	0.34	0.22	0.83
$ß_6$	-0.242	0.28	-0.86	0.39
$ß_7$	0.099	0.45	0.22	0.83
$ß_8$	0.103	0.46	0.22	0.82
$ß_9$	-0.023	0.29	-0.08	0.94
$ß_{10}$	0.003	0.23	0.01	0.99
$ß_{11}$	0.036	0.35	0.10	0.92
$ß_{12}$	-0.139	0.26	-0.53	0.60
$ß_{13}$	-0.169	0.29	-0.59	0.56
$ß_{14}$	0.125	0.27	0.46	0.65
$ß_0$	3.596	0.48	7.46	0.00

See Figure 2, page 26, for variables definitions.

Table A5. Price Imputation Coefficients for Brand Five

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
$ß_1$	0.000	0.00	2.11	0.05
$ß_2$	4.370	1.39	3.15	0.00
$ß_3$	2.983	1.30	2.30	0.03
$ß_4$	1.414	0.85	1.65	0.11
$ß_5$	-0.903	0.51	-1.76	0.09
$ß_6$	0.142	0.50	0.28	0.78
$ß_7$	-1.311	1.00	-1.31	0.20
$ß_8$	-1.210	0.83	-1.46	0.16
$ß_9$	-2.220	0.67	-3.30	0.00
$ß_{10}$	0.021	0.39	0.06	0.96
$ß_{11}$	1.006	0.79	1.27	0.22
$ß_{12}$	1.488	0.69	2.14	0.04
$ß_{13}$	-0.146	0.48	-0.30	0.76
$ß_{14}$	1.409	0.86	1.64	0.11
$ß_0$	7.423	1.49	4.99	0.00

See Figure 2, page 26, for variables definitions.

Table A6. Price Imputation Coefficients for Brand Six

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
$ß_1$	0.000	0.00	0.35	0.73
$ß_2$	-0.124	0.60	-0.21	0.84
$ß_3$	-0.016	0.48	-0.03	0.97
$ß_4$	0.044	0.39	0.11	0.91
$ß_5$	0.898	0.39	2.32	0.02
$ß_6$	-0.197	0.33	-0.61	0.55
$ß_7$	0.018	0.42	0.04	0.97
$ß_8$	0.384	0.46	0.83	0.41
$ß_9$	0.250	0.31	0.80	0.43
$ß_{10}$	-0.017	0.26	-0.07	0.95
$ß_{11}$	-0.112	0.39	-0.29	0.78
$ß_{12}$	0.055	0.29	0.19	0.85
$ß_{13}$	0.119	0.29	0.41	0.68
$ß_{14}$	0.479	0.38	1.26	0.22
$ß_0$	2.703	0.61	4.43	0.00

See Figure 2, page 26, for variables definitions.

Table A7. Price Imputation Coefficients for Brand Seven

Variable Name	Estimated Coefficient	Standard Error	t-statistic	p-value
$ß_1$	0.000	0.00	1.95	0.05
$ß_2$	1.872	1.34	1.40	0.16
$ß_3$	-0.576	1.08	-0.53	0.59
$ß_4$	-0.977	0.94	-1.04	0.30
$ß_5$	0.917	0.89	1.03	0.31
$ß_6$	-0.793	0.80	-1.00	0.32
$ß_7$	0.139	1.09	0.13	0.90
$ß_8$	0.520	1.03	0.50	0.61
$ß_9$	-0.516	0.75	-0.69	0.49
$ß_{10}$	0.194	0.72	0.27	0.79
$ß_{11}$	0.132	0.93	0.14	0.89
$ß_{12}$	0.472	0.74	0.64	0.52
$ß_{13}$	-0.211	0.89	-0.24	0.81
$ß_{14}$	1.479	0.78	1.90	0.06
$ß_0$	2.685	1.29	2.08	0.04

See Figure 2, page 26, for variables definitions.

Table A8. R-Squares for the Price Imputation Models

Brand	R-Square
Brand 1	0.05
Brand 2	0.10
Brand 3	0.24
Brand 4	0.07
Brand 5	0.50
Brand 6	0.17
Brand 7	0.17

APPENDIX B

LA/AIDS PARAMETER ESTIMATES FOR THE CHAPTER III MODEL

Table B1. Coefficient Estimates of the LA/AIDS Model Using Generalized Method of Moments

Coefficient	Coefficient Estimate	Standard Error	T- Ratio
α_{11}	-0.1839	0.0690	-2.66
α_{12}	0.1601	0.0526	3.04
α_{13}	0.0314	0.0178	1.76
α_{14}	-0.0708	0.0252	-2.81
α_{15}	-0.0010	0.0264	-0.04
α_{16}	-0.0049	0.0185	-0.27
α_{22}	-0.2118	0.0714	-2.97
α_{23}	0.0189	0.0131	1.45
α_{24}	0.0412	0.0242	1.70
α_{25}	-0.0012	0.0173	-0.07
α_{26}	0.0221	0.0111	1.99
α_{33}	0.0003	0.0287	0.01
α_{34}	0.0099	0.0219	0.45
α_{35}	-0.0192	0.0177	-1.08
α_{36}	-0.0595	0.0230	-2.58
α_{44}	0.0158	0.0515	0.31
α_{45}	0.0026	0.0236	0.11
α_{46}	0.0083	0.0228	0.37
α_{55}	0.0197	0.0228	0.86
α_{56}	-0.0116	0.0204	-0.57
α_{66}	0.0511	0.0324	1.58
b_1	-0.0258	0.0170	-1.52
b_2	0.0381	0.0162	2.34
b_3	0.0077	0.0051	1.51
b_4	0.0057	0.0048	1.19
b_5	-0.0073	0.0065	-1.12
b_6	-0.0056	0.0043	-1.30
α_1	0.4794	0.0489	9.80
α_2	0.2639	0.0553	4.77
α_3	0.0322	0.0195	1.65
α_4	0.0507	0.0305	1.66
α_5	0.0063	0.0260	0.24
α_6	0.0581	0.0254	2.29

See Figure 1, page 23, for a definition of the coefficients.

APPENDIX C

COEFFICIENT DESCRIPTION FOR BOTH THE NERLOVIAN AND WAUGHIAN HEDONIC MODELS

Table C1. Coefficient Description for Both the Nerlovian and Waughian Hedonic Models

Coefficient	Name	Definition
$?_{p}$	UNTPRICE	Unit Price
$ß_{1i}$	AVGINC	Average Household Income
$ß_{2i}$	AGEF25	Female head of household less then age 25
$ß_{3i}$	AGEF50	Female head of household between 40 and 65 years old
$ß_{4i}$	AGEF65	Female head of household 65 years old or older
$ß_{5i}$	UNEMP	Female head of household unemployed
$ß_{6i}$	PTEMP	Female head of household employed, but less than 30 hours
$ß_{7i}$	EDUFH	Female head of household with a high school education or less
$ß_{8i}$	EDUFCP	Female head of household with a college degree
$ß_{9i}$	BLACK	Race type of black
$ß_{10i}$	OTHER	Race type other than black or white
$ß_{11i}$	HISPY	Hispanic ethnicity
$ß_{12i}$	NONMETRO	Household located outside of a city
$ß_{13i}$	EAST	Eastern Region of the U.S.
$ß_{14i}$	WEST	Western Region of the U.S.
$ß_{15i}$	CENTRAL	Central Region of the U.S.
$ß_{16i}$	WIDOWED	Martial Status in the household, widowed
$ß_{17i}$	DIVORCED	Martial Status in the household, divorced
$ß_{18i}$	SINGLE	Martial Status in the household, single
$ß_{19i}$	HS1	A household of one person
$ß_{20i}$	HS2	A household of two people
$ß_{21ji}$	HS3	A household of three people
$?_{1j}$	JAN	Month of January
$?_{2j}$	FEB	Month of February
$?_{3j}$	MCH	Month of March
$?_{4j}$	APR	Month of April
$?_{5j}$	MAY	Month of May
$?_{6j}$	JNE	Month of June
$?_{7j}$	JLY	Month of July
$?_{8j}$	AUG	Month of August
$?_{9j}$	SEP	Month of September
$?_{10j}$	OCT	Month of October
$?_{11j}$	NOV	Month of November
a_{k1}	*BNAME*	Brand Type Characteristic
a_{k2}	*NTPLSTIC*	Container type characteristic
a_{k3}	*SKIM*	White skim milk (fat type)
a_{k4}	*LOWFAT*	White lowfat milk (fat type)
a_{k5}	*WHOLE*	White whole milk (fat type)
$ß_{0}$	CONSTANT	Intercept term, the value of the base scenario

See Figures 5 and 6 for coefficient specification in equations.

APPENDIX D

THE HEDONIC MODEL RESULTS

Table D1. Waughian Hedonic Model Results, Gallon-Size Container

Coefficient Name	Coefficient Estimate	Standard Error	t-statistic	p-value
AVGINC	0.00	0.00	21.00	0.00
AGEF25	4.46	0.33	13.70	0.00
AGEF50	-1.33	0.34	-3.89	0.00
AGEF65	-5.03	0.52	-9.75	0.00
UNEMP	-1.38	0.32	-4.36	0.00
PTEMP	-1.13	0.34	-3.28	0.00
EDUFH	2.67	0.32	8.24	0.00
EDUFCP	-0.28	0.30	-0.92	0.36
BLACK	1.33	0.61	2.19	0.03
OTHER	1.24	0.65	1.91	0.06
HISPY	1.81	0.58	3.11	0.00
NONMETRO	-2.92	0.36	-8.05	0.00
EAST	-0.17	0.37	-0.46	0.65
WEST	2.58	0.37	6.92	0.00
CENTRAL	-14.11	0.33	-42.36	0.00
WIDOWED	8.21	0.72	11.47	0.00
DIVORCED	2.54	0.51	4.93	0.00
SINGLE	4.06	0.60	6.75	0.00
HS1	3.61	0.66	5.49	0.00
HS2	2.45	0.34	7.14	0.00
HS3	3.09	0.35	8.77	0.00
JAN	1.42	0.60	2.36	0.02
FEB	6.04	0.61	9.85	0.00
MCH	4.44	0.60	7.44	0.00
APR	-21.62	0.61	-35.65	0.00
MAY	-18.66	0.60	-30.98	0.00
JNE	-17.06	0.61	-27.83	0.00
JLY	-17.66	0.61	-29.04	0.00
AUG	-22.24	0.61	-36.58	0.00
SEP	-12.72	0.61	-20.72	0.00
OCT	5.74	0.61	9.41	0.00
NOV	11.11	0.62	17.88	0.00
BNAME	*6.54*	*0.27*	*24.12*	*0.00*
NTPLSTIC	*-17.51*	*1.52*	*-11.53*	*0.00*
SKIM	*-6.71*	*0.32*	*-20.74*	*0.00*
LOWFAT	*0.83*	*0.36*	*2.29*	*0.02*
WHOLE	*14.94*	*0.36*	*41.75*	*0.00*
CONSTANT	249.03	0.71	348.81	0.00

Italics indicate attribute variables. See Appendix C for parameter explanation.

Table D2. Nerlovian Hedonic Model Results, Gallon-Size Container

Coefficient Name	Coefficient Estimate	Standard Error	t-statistic	p-value
UNTPRICE	*0.00*	*0.00*	*-31.34*	*0.00*
AVGINC	0.00	0.00	6.35	0.00
AGEF25	-0.02	0.00	-3.61	0.00
AGEF50	0.01	0.00	2.09	0.04
AGEF65	-0.04	0.01	-5.74	0.00
UNEMP	0.00	0.00	-0.02	0.98
PTEMP	-0.04	0.00	-9.78	0.00
EDUFH	-0.02	0.00	-3.85	0.00
EDUFCP	0.01	0.00	1.82	0.07
BLACK	-0.09	0.01	-11.31	0.00
OTHER	0.03	0.01	3.88	0.00
NONMETRO	-0.02	0.00	-3.64	0.00
EAST	-0.01	0.00	-1.20	0.23
WEST	0.27	0.00	57.73	0.00
CENTRAL	0.06	0.00	13.17	0.00
WIDOWED	0.03	0.01	3.66	0.00
DIVORCED	0.01	0.01	0.89	0.37
SINGLE	-0.04	0.01	-5.04	0.00
NOKIDS	-0.02	0.01	-4.15	0.00
HS1	-0.27	0.01	-29.18	0.00
HS2	-0.20	0.01	-35.45	0.00
HS3	-0.09	0.00	-19.47	0.00
JAN	-0.03	0.01	-4.08	0.00
FEB	-0.01	0.01	-1.74	0.08
MCH	0.00	0.01	-0.65	0.51
APR	-0.03	0.01	-4.00	0.00
MAY	-0.03	0.01	-4.40	0.00
JNE	-0.03	0.01	-3.27	0.00
JLY	-0.03	0.01	-4.40	0.00
AUG	-0.05	0.01	-5.95	0.00
SEP	-0.02	0.01	-3.02	0.00
OCT	-0.01	0.01	-1.26	0.21
NOV	0.00	0.01	0.30	0.76
BNAME	*0.02*	*0.00*	*6.59*	*0.00*
NTPLSTIC	*0.39*	*0.02*	*20.37*	*0.00*
SKIM	*0.02*	*0.00*	*4.14*	*0.00*
LOWFAT	*0.03*	*0.00*	*6.45*	*0.00*
WHOLE	*-0.03*	*0.00*	*-5.56*	*0.00*
CONSTANT	1.57	0.01	127.82	0.00

Italics indicate attribute variables. See Appendix C for parameter explanation.

Table D3. Waughian Hedonic Model Results, Half-Gallon-Size Container

Coefficient Name	Coefficient Estimate	Standard Error	t-statistic	p-value
AVGINC	0.00	0.00	16.83	0.00
AGEF25	1.55	0.48	3.20	0.00
AGEF50	-0.73	0.43	-1.67	0.09
AGEF65	0.10	0.54	0.18	0.86
BLACK	9.94	0.62	15.99	0.00
OTHER	14.12	0.72	19.54	0.00
NONMETRO	-9.85	0.45	-21.73	0.00
EAST	-17.95	0.41	-43.31	0.00
WEST	13.31	0.48	27.82	0.00
CENTRAL	-11.57	0.50	-22.98	0.00
WIDOWED	2.27	0.63	3.59	0.00
DIVORCED	5.67	0.51	11.15	0.00
SINGLE	3.15	0.51	6.15	0.00
NOKIDS	2.25	0.43	5.19	0.00
JAN	0.13	0.76	0.17	0.87
FEB	1.13	0.77	1.46	0.14
MCH	3.85	0.76	5.04	0.00
APR	-8.93	0.77	-11.61	0.00
MAY	-8.22	0.77	-10.72	0.00
JNE	-10.73	0.77	-13.88	0.00
JLY	-10.02	0.77	-13.02	0.00
AUG	-9.61	0.77	-12.51	0.00
SEP	-7.78	0.78	-10.01	0.00
OCT	1.99	0.77	2.59	0.01
NOV	3.23	0.78	4.14	0.00
BNAME	*20.70*	*0.33*	*62.56*	*0.00*
NTPLSTIC	*9.47*	*0.33*	*28.60*	*0.00*
SKIM	*8.39*	*0.39*	*21.28*	*0.00*
LOWFAT	*4.78*	*0.46*	*10.40*	*0.00*
WHOLE	*3.82*	*0.46*	*8.33*	*0.00*
CONSTANT	149.66	0.87	171.97	0.00

Italics indicate attribute variables. See Appendix C for parameter explanation.

Table D4. Nerlovian Hedonic Model Results, Half-Gallon-Size Container

Coefficient Name	Coefficient Estimate	Standard Error	t-statistic	p-value
UNTPRICE	*0.00*	*0.00*	*-25.76*	*0.00*
AVGINC	0.00	0.00	-16.05	0.00
AGEF25	-0.05	0.01	-7.72	0.00
AGEF50	-0.02	0.01	-3.57	0.00
AGEF65	-0.07	0.01	-7.78	0.00
UNEMP	0.01	0.01	1.22	0.22
PTEMP	-0.02	0.01	-3.20	0.00
EDUFH	-0.01	0.01	-1.12	0.26
EDUFCP	0.03	0.01	5.24	0.00
BLACK	-0.04	0.01	-4.32	0.00
OTHER	-0.05	0.01	-4.42	0.00
HISPY	-0.06	0.01	-5.71	0.00
NONMETRO	0.05	0.01	8.68	0.00
EAST	0.01	0.01	1.07	0.29
WEST	0.11	0.01	16.97	0.00
CENTRAL	0.10	0.01	14.21	0.00
WIDOWED	-0.07	0.01	-7.14	0.00
DIVORCED	-0.06	0.01	-6.99	0.00
SINGLE	-0.06	0.01	-6.31	0.00
NOKIDS	-0.04	0.01	-4.39	0.00
HS1	-0.31	0.01	-26.85	0.00
HS2	-0.24	0.01	-28.93	0.00
HS3	-0.21	0.01	-28.25	0.00
JAN	-0.02	0.01	-1.49	0.14
FEB	0.00	0.01	-0.02	0.98
MCH	-0.01	0.01	-1.11	0.27
APR	0.03	0.01	2.92	0.00
MAY	-0.02	0.01	-2.00	0.05
JNE	-0.01	0.01	-0.88	0.38
JLY	-0.01	0.01	-1.14	0.25
AUG	0.00	0.01	0.43	0.67
SEP	0.00	0.01	-0.45	0.65
OCT	0.01	0.01	1.03	0.30
NOV	0.04	0.01	3.58	0.00
BNAME	*0.05*	*0.00*	*11.24*	*0.00*
NTPLSTIC	*0.08*	*0.00*	*17.02*	*0.00*
SKIM	*-0.02*	*0.01*	*-2.97*	*0.00*
LOWFAT	*-0.01*	*0.01*	*-1.89*	*0.06*
WHOLE	*-0.07*	*0.01*	*-10.49*	*0.00*
CONSTANT	1.65	0.02	107.16	0.00

Italics indicate attribute variables. See Appendix C for parameter explanation.

Table D5. Waughian Hedonic Model Results, Quart-Size Container

Coefficient Name	Coefficient Estimate	Standard Error	t-statistic	p-value
AVGINC	0.00	0.00	1.24	0.22
AGEF25	-1.45	0.73	-1.98	0.05
AGEF50	3.09	0.60	5.10	0.00
AGEF65	2.67	0.72	3.74	0.00
EDUFH	3.03	0.59	5.16	0.00
EDUFCP	1.53	0.53	2.88	0.00
BLACK	5.08	0.70	7.29	0.00
OTHER	8.26	0.86	9.57	0.00
NONMETRO	-12.84	0.67	-19.10	0.00
EAST	-22.19	0.57	-39.00	0.00
WEST	6.83	0.64	10.60	0.00
CENTRAL	-1.50	0.72	-2.08	0.04
WIDOWED	2.39	0.87	2.75	0.01
DIVORCED	2.44	0.81	3.01	0.00
SINGLE	4.45	0.79	5.60	0.00
HS1	-5.38	1.04	-5.16	0.00
HS2	-0.75	0.82	-0.92	0.36
HS3	3.82	0.96	4.00	0.00
JAN	0.47	1.05	0.45	0.65
FEB	1.26	1.06	1.19	0.23
MCH	1.18	1.04	1.14	0.25
APR	-3.77	1.05	-3.58	0.00
MAY	-4.62	1.04	-4.44	0.00
JNE	-4.54	1.05	-4.32	0.00
JLY	-4.35	1.04	-4.17	0.00
AUG	-4.99	1.05	-4.77	0.00
SEP	-4.17	1.05	-3.98	0.00
OCT	1.74	1.04	1.67	0.09
NOV	1.93	1.07	1.80	0.07
BNAME	*13.38*	*0.45*	*29.62*	*0.00*
NTPLSTIC	*-10.96*	*0.65*	*-16.75*	*0.00*
SKIM	*6.67*	*0.55*	*12.15*	*0.00*
LOWFAT	*9.03*	*0.76*	*11.88*	*0.00*
WHOLE	*-1.15*	*0.59*	*-1.94*	*0.05*
CONSTANT	115.12	1.46	78.66	0.00

Italics indicate attribute variables. See Appendix C for parameter explanation.

Table D6. Nerlovian Hedonic Model Results, Quart-Size Container

Coefficient Name	Coefficient Estimate	Standard Error	t-statistic	p-value
UNTPRICE	*0.00*	*0.00*	*4.16*	*0.00*
AVGINC	0.00	0.00	-7.06	0.00
AGEF25	-0.02	0.01	-2.01	0.04
AGEF50	0.01	0.01	1.45	0.15
AGEF65	-0.04	0.01	-2.98	0.00
UNEMP	0.05	0.01	5.29	0.00
PTEMP	-0.03	0.01	-2.87	0.00
EDUFH	0.02	0.01	2.13	0.03
EDUFCP	0.07	0.01	8.53	0.00
BLACK	0.03	0.01	2.85	0.00
OTHER	0.02	0.01	1.11	0.27
NONMETRO	0.04	0.01	3.59	0.00
EAST	-0.01	0.01	-1.47	0.14
WEST	0.03	0.01	3.19	0.00
CENTRAL	0.02	0.01	2.04	0.04
WIDOWED	0.06	0.01	4.59	0.00
DIVORCED	0.04	0.01	3.11	0.00
SINGLE	0.04	0.01	2.89	0.00
NOKIDS	-0.05	0.02	-3.36	0.00
HS1	-0.16	0.02	-8.34	0.00
HS2	-0.10	0.02	-6.15	0.00
HS3	-0.07	0.02	-4.70	0.00
BNAME	*0.05*	*0.01*	*7.08*	*0.00*
NTPLSTIC	*0.03*	*0.01*	*3.17*	*0.00*
SKIM	*0.02*	*0.01*	*2.50*	*0.01*
LOWFAT	*0.00*	*0.01*	*-0.04*	*0.97*
WHOLE	*-0.03*	*0.01*	*-2.90*	*0.00*
CONSTANT	1.11	0.02	45.57	0.00

Italics indicate attribute variables. See Appendix C for parameter explanation.

Table D7. Goodness-of-Fit Measures for the Hedonic Models

Model	R-Square
Waughian Gallon-size	0.11
Nerlovian Gallon-size	0.07
Waughian Half-Gallon-size	0.14
Nerlovian Half-Gallon-size	0.07
Waughian Quart Size	0.19
Nerlovian Quart Size	0.03

APPENDIX E

PRICE IMPUTATION COEFFICIENTS FOR CHAPTER V

Table E1. Price Imputation Equation Coefficient Estimates for Fruit Juice in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	4.15	0.00
$ß_2$	0.35	0.05	7.25	0.00
$ß_3$	0.23	0.04	5.60	0.00
$ß_4$	0.06	0.04	1.67	0.10
$ß_5$	0.04	0.03	1.33	0.19
$ß_6$	0.07	0.03	2.41	0.02
$ß_7$	0.23	0.04	5.23	0.00
$ß_8$	0.27	0.04	7.04	0.00
$ß_9$	-0.09	0.03	-3.00	0.00
$ß_{10}$	0.03	0.03	1.13	0.26
$ß_{11}$	-0.10	0.03	-3.25	0.00
$ß_{12}$	0.01	0.03	0.37	0.71
$ß_{13}$	-0.05	0.03	-1.72	0.09
$ß_{14}$	-0.07	0.05	-1.63	0.10
$ß_{15}$	0.00	0.03	-0.12	0.90
$ß_{16}$	-0.04	0.03	-1.36	0.18
$ß_{17}$	0.00	0.03	0.13	0.90
$ß_{18}$	0.04	0.03	1.32	0.19
$ß_0$	1.18	0.07	17.85	0.00

See Figure 9 for an explanation of the coefficients.

Table E2. Price Imputation Equation Coefficient Estimates for Fruit Juice in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	10.77	0.00
$ß_2$	0.16	0.03	5.23	0.00
$ß_3$	0.11	0.03	4.07	0.00
$ß_4$	0.05	0.02	2.10	0.04
$ß_5$	0.04	0.02	2.04	0.04
$ß_6$	0.03	0.02	1.69	0.09
$ß_7$	0.08	0.03	3.05	0.00
$ß_8$	0.09	0.02	3.46	0.00
$ß_9$	-0.04	0.02	-2.33	0.02
$ß_{10}$	0.03	0.02	1.70	0.09
$ß_{11}$	-0.05	0.02	-2.70	0.01
$ß_{12}$	-0.04	0.02	-2.39	0.02
$ß_{13}$	-0.06	0.02	-2.76	0.01
$ß_{14}$	-0.04	0.03	-1.49	0.14
$ß_{15}$	-0.01	0.02	-0.55	0.58
$ß_{16}$	-0.05	0.02	-2.79	0.01
$ß_{17}$	0.20	0.02	9.67	0.00
$ß_{18}$	-0.04	0.02	-1.99	0.05
$ß_0$	1.77	0.04	41.10	0.00

See Figure 9 for an explanation of the coefficients.

Table E3. Price Imputation Equation Coefficient Estimates for Fruit Juice in the Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	12.63	0.00
$ß_2$	0.58	0.10	5.97	0.00
$ß_3$	0.22	0.08	2.90	0.00
$ß_4$	0.14	0.07	2.06	0.04
$ß_5$	0.08	0.06	1.45	0.15
$ß_6$	0.17	0.06	2.87	0.00
$ß_7$	0.30	0.09	3.40	0.00
$ß_8$	0.06	0.07	0.89	0.37
$ß_9$	-0.09	0.06	-1.51	0.13
$ß_{10}$	0.09	0.05	1.81	0.07
$ß_{11}$	-0.38	0.06	-6.77	0.00
$ß_{12}$	-0.03	0.06	-0.50	0.62
$ß_{13}$	0.02	0.06	0.41	0.68
$ß_{14}$	-0.07	0.08	-0.83	0.41
$ß_{15}$	0.02	0.06	0.38	0.70
$ß_{16}$	-0.04	0.06	-0.61	0.54
$ß_{17}$	0.26	0.06	4.26	0.00
$ß_{18}$	-0.17	0.07	-2.66	0.01
$ß_0$	2.49	0.12	20.22	0.00

See Figure 9 for an explanation of the coefficients.

Table E4. Price Imputation Equation Coefficient Estimates for Bottled Water in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
β_1	0.00	0.00	-1.34	0.18
β_2	0.14	0.05	2.63	0.01
β_3	0.10	0.04	2.26	0.02
β_4	0.03	0.04	0.84	0.40
β_5	0.04	0.03	1.29	0.20
β_6	-0.03	0.03	-0.80	0.43
β_7	0.04	0.05	0.74	0.46
β_8	-0.04	0.04	-1.07	0.29
β_9	0.00	0.03	-0.11	0.91
β_{10}	0.02	0.03	0.60	0.55
β_{11}	0.04	0.03	1.12	0.26
β_{12}	-0.03	0.03	-0.84	0.40
β_{13}	-0.04	0.03	-1.06	0.29
β_{14}	-0.04	0.05	-0.77	0.44
β_{15}	0.00	0.03	-0.12	0.91
β_{16}	0.03	0.03	0.91	0.36
β_{17}	-0.14	0.03	-4.03	0.00
β_{18}	0.05	0.04	1.30	0.19
β_0	1.56	0.07	22.40	0.00

See Figure 9 for an explanation of the coefficients.

Table E5. Price Imputation Equation Coefficient Estimates for Bottled Water in the Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	4.16	0.00
$ß_2$	0.03	0.02	1.74	0.08
$ß_3$	0.00	0.02	0.12	0.91
$ß_4$	0.00	0.01	0.27	0.78
$ß_5$	0.00	0.01	-0.04	0.97
$ß_6$	-0.02	0.01	-1.71	0.09
$ß_7$	-0.02	0.02	-1.15	0.25
$ß_8$	0.01	0.01	0.95	0.34
$ß_9$	0.01	0.01	1.17	0.24
$ß_{10}$	0.01	0.01	1.45	0.15
$ß_{11}$	0.04	0.01	3.64	0.00
$ß_{12}$	-0.01	0.01	-0.93	0.35
$ß_{13}$	-0.01	0.01	-0.72	0.47
$ß_{14}$	0.01	0.02	0.33	0.74
$ß_{15}$	0.02	0.01	1.90	0.06
$ß_{16}$	0.03	0.01	2.81	0.01
$ß_{17}$	0.01	0.01	1.10	0.27
$ß_{18}$	-0.04	0.01	-3.39	0.00
$ß_0$	0.70	0.02	28.52	0.00

See Figure 9 for an explanation of the coefficients.

Table E6. Price Imputation Equation Coefficient Estimates for Carbonated Soft Drinks in the Pint Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	2.43	0.02
$ß_2$	0.05	0.01	6.65	0.00
$ß_3$	0.02	0.01	3.19	0.00
$ß_4$	0.00	0.01	0.08	0.93
$ß_5$	0.01	0.00	1.74	0.08
$ß_6$	0.00	0.00	-1.00	0.32
$ß_7$	-0.01	0.01	-1.22	0.22
$ß_8$	0.01	0.01	1.48	0.14
$ß_9$	-0.01	0.00	-1.54	0.12
$ß_{10}$	0.01	0.00	2.16	0.03
$ß_{11}$	0.02	0.00	4.99	0.00
$ß_{12}$	-0.01	0.00	-2.31	0.02
$ß_{13}$	0.00	0.00	-0.63	0.53
$ß_{14}$	0.00	0.01	0.32	0.75
$ß_{15}$	0.02	0.00	4.26	0.00
$ß_{16}$	-0.04	0.00	-8.54	0.00
$ß_{17}$	-0.02	0.00	-3.14	0.00
$ß_{18}$	0.00	0.01	-0.27	0.79
$ß_0$	0.31	0.01	29.86	0.00

See Figure 9 for an explanation of the coefficients.

Table E7. Price Imputation Equation Coefficient Estimates for Carbonated Soft Drinks in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	-3.94	0.00
$ß_2$	-0.01	0.02	-0.57	0.57
$ß_3$	-0.01	0.02	-0.48	0.63
$ß_4$	-0.01	0.02	-0.56	0.58
$ß_5$	0.08	0.01	5.52	0.00
$ß_6$	-0.03	0.01	-1.89	0.06
$ß_7$	-0.05	0.02	-2.24	0.03
$ß_8$	-0.01	0.02	-0.38	0.71
$ß_9$	0.03	0.01	2.29	0.02
$ß_{10}$	0.01	0.01	0.51	0.61
$ß_{11}$	0.04	0.01	2.89	0.00
$ß_{12}$	-0.04	0.01	-2.98	0.00
$ß_{13}$	-0.02	0.01	-1.60	0.11
$ß_{14}$	0.00	0.02	-0.21	0.83
$ß_{15}$	-0.10	0.01	-7.19	0.00
$ß_{16}$	-0.02	0.01	-1.56	0.12
$ß_{17}$	0.14	0.02	9.08	0.00
$ß_{18}$	0.05	0.02	3.16	0.00
$ß_0$	0.98	0.03	31.38	0.00

See Figure 9 for an explanation of the coefficients.

Table E8. Price Imputation Equation Coefficient Estimates for Carbonated Soft Drinks in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	13.93	0.00
$ß_2$	0.27	0.03	9.12	0.00
$ß_3$	0.16	0.03	6.39	0.00
$ß_4$	0.09	0.02	3.94	0.00
$ß_5$	0.02	0.02	1.28	0.20
$ß_6$	0.04	0.02	1.91	0.06
$ß_7$	0.08	0.03	2.90	0.00
$ß_8$	0.08	0.02	3.34	0.00
$ß_9$	-0.04	0.02	-2.47	0.01
$ß_{10}$	0.06	0.02	3.76	0.00
$ß_{11}$	-0.12	0.02	-6.34	0.00
$ß_{12}$	-0.04	0.02	-2.01	0.04
$ß_{13}$	-0.02	0.02	-1.26	0.21
$ß_{14}$	-0.03	0.03	-1.11	0.27
$ß_{15}$	0.02	0.02	1.03	0.30
$ß_{16}$	-0.04	0.02	-1.95	0.05
$ß_{17}$	0.14	0.02	7.10	0.00
$ß_{18}$	-0.03	0.02	-1.66	0.10
$ß_0$	1.53	0.04	36.89	0.00

See Figure 9 for an explanation of the coefficients.

Table E9. Price Imputation Equation Coefficient Estimates for Flavored Milk in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	0.62	0.54
$ß_2$	-0.05	0.05	-1.16	0.25
$ß_3$	-0.07	0.04	-1.83	0.07
$ß_4$	-0.02	0.03	-0.65	0.52
$ß_5$	0.04	0.03	1.46	0.15
$ß_6$	0.01	0.03	0.38	0.71
$ß_7$	0.00	0.05	0.06	0.96
$ß_8$	0.04	0.03	1.15	0.25
$ß_9$	-0.02	0.03	-0.61	0.54
$ß_{10}$	0.00	0.03	-0.15	0.88
$ß_{11}$	0.07	0.03	2.24	0.03
$ß_{12}$	-0.05	0.03	-1.79	0.07
$ß_{13}$	-0.08	0.03	-2.67	0.01
$ß_{14}$	-0.01	0.04	-0.30	0.76
$ß_{15}$	-0.03	0.03	-1.05	0.30
$ß_{16}$	-0.02	0.03	-0.74	0.46
$ß_{17}$	0.07	0.03	2.07	0.04
$ß_{18}$	-0.10	0.03	-3.49	0.00
$ß_0$	1.47	0.06	24.13	0.00

See Figure 9 for an explanation of the coefficients.

Table E10. Price Imputation Equation Coefficient Estimates for Flavored Milk in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	3.51	0.00
$ß_2$	0.18	0.08	2.25	0.02
$ß_3$	0.09	0.06	1.51	0.13
$ß_4$	0.08	0.05	1.54	0.13
$ß_5$	0.09	0.04	2.00	0.05
$ß_6$	0.03	0.05	0.62	0.54
$ß_7$	-0.04	0.07	-0.48	0.63
$ß_8$	-0.05	0.05	-0.97	0.33
$ß_9$	-0.06	0.04	-1.41	0.16
$ß_{10}$	0.00	0.04	0.03	0.97
$ß_{11}$	0.03	0.06	0.43	0.67
$ß_{12}$	0.01	0.04	0.13	0.90
$ß_{13}$	-0.03	0.05	-0.68	0.50
$ß_{14}$	-0.14	0.08	-1.81	0.07
$ß_{15}$	0.03	0.05	0.58	0.56
$ß_{16}$	-0.21	0.04	-4.71	0.00
$ß_{17}$	0.21	0.06	3.55	0.00
$ß_{18}$	-0.04	0.05	-0.90	0.37
$ß_0$	1.75	0.11	16.48	0.00

See Figure 9 for an explanation of the coefficients.

Table E11. Price Imputation Equation Coefficient Estimates for White Milk in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	2.28	0.02
$ß_2$	-0.06	0.03	-2.16	0.03
$ß_3$	-0.07	0.02	-2.86	0.00
$ß_4$	-0.04	0.02	-1.87	0.06
$ß_5$	0.01	0.02	0.58	0.56
$ß_6$	0.02	0.02	1.27	0.21
$ß_7$	0.04	0.02	1.87	0.06
$ß_8$	0.02	0.02	1.02	0.31
$ß_9$	0.03	0.02	1.60	0.11
$ß_{10}$	0.00	0.01	0.17	0.87
$ß_{11}$	0.06	0.01	3.99	0.00
$ß_{12}$	-0.03	0.02	-1.74	0.08
$ß_{13}$	-0.03	0.02	-1.58	0.12
$ß_{14}$	-0.01	0.03	-0.21	0.84
$ß_{15}$	-0.20	0.01	-13.58	0.00
$ß_{16}$	0.00	0.02	0.27	0.79
$ß_{17}$	0.01	0.02	0.80	0.42
$ß_{18}$	-0.10	0.02	-5.45	0.00
$ß_0$	1.17	0.04	31.81	0.00

See Figure 9 for an explanation of the coefficients.

Table E12. Price Imputation Equation Coefficient Estimates for White Milk in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	4.63	0.00
$ß_2$	0.06	0.02	2.40	0.02
$ß_3$	0.01	0.02	0.29	0.77
$ß_4$	0.00	0.02	0.24	0.81
$ß_5$	0.02	0.02	1.52	0.13
$ß_6$	-0.01	0.01	-0.86	0.39
$ß_7$	-0.01	0.02	-0.39	0.70
$ß_8$	0.03	0.02	1.58	0.12
$ß_9$	0.01	0.01	0.41	0.68
$ß_{10}$	0.01	0.01	0.93	0.35
$ß_{11}$	0.09	0.02	6.02	0.00
$ß_{12}$	-0.01	0.01	-0.51	0.61
$ß_{13}$	-0.01	0.02	-0.71	0.48
$ß_{14}$	-0.02	0.02	-0.85	0.40
$ß_{15}$	-0.06	0.01	-4.13	0.00
$ß_{16}$	-0.07	0.02	-4.47	0.00
$ß_{17}$	0.18	0.02	11.80	0.00
$ß_{18}$	-0.09	0.02	-5.62	0.00
$ß_0$	1.57	0.03	47.34	0.00

See Figure 9 for an explanation of the coefficients.

Table E13. Price Imputation Equation Coefficient Estimates for White Milk in the Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic	p-value
$ß_1$	0.00	0.00	3.40	0.00
$ß_2$	0.00	0.02	0.01	0.99
$ß_3$	0.00	0.02	-0.12	0.91
$ß_4$	0.01	0.02	0.47	0.64
$ß_5$	0.06	0.01	4.17	0.00
$ß_6$	0.00	0.01	-0.09	0.93
$ß_7$	0.00	0.02	0.03	0.97
$ß_8$	-0.01	0.02	-0.49	0.63
$ß_9$	0.03	0.01	2.42	0.02
$ß_{10}$	-0.01	0.01	-0.66	0.51
$ß_{11}$	0.03	0.02	1.78	0.08
$ß_{12}$	-0.03	0.01	-2.61	0.01
$ß_{13}$	-0.03	0.01	-2.40	0.02
$ß_{14}$	0.00	0.02	-0.17	0.87
$ß_{15}$	0.00	0.01	0.04	0.97
$ß_{16}$	-0.14	0.01	-10.43	0.00
$ß_{17}$	0.04	0.01	2.97	0.00
$ß_{18}$	-0.03	0.01	-2.17	0.03
$ß_0$	2.52	0.03	81.95	0.00

See Figure 9 for an explanation of the coefficients.

Table E14. Goodness-of-Fit for the Price Imputation Models

Model	R-square
Fruit Juice Quarts	0.10
Fruit Juice Half-Gallons	0.07
Fruit Juice Gallons	0.09
Bottled Water Half-Gallons	0.01
Bottled Water Gallons	0.03
Carbonated Soft Drink Pints	0.05
Carbonated Soft Drink Quarts	0.07
Carbonated Soft Drink Half-Gallons	0.10
Flavored Milk Quarts	0.03
Flavored Milk Half-Gallons	0.10
White Milk Quarts	0.11
White Milk Half-Gallons	0.08
White Milk Gallons	0.05

APPENDIX F

PROBIT COEFFICIENT ESTIMATES

Table F1. Probit Coefficient Estimates for the Presence of Fruit Juice in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	2.75
HS1	-0.806	0.092	-8.77
HS2	-0.438	0.084	-5.19
HS3	-0.219	0.084	-2.61
AGEF25	0.042	0.059	0.71
AGEF50	-0.074	0.051	-1.43
AGEF65	-0.080	0.069	-1.16
CHILD0	-0.487	0.079	-6.13
EDUFH	-0.003	0.051	-0.51
EDUFCP	-0.045	0.046	-0.98
OTHER	0.325	0.060	5.38
UNEMP	0.004	0.051	0.79
PTEMP	0.136	0.058	2.33
HISPN	0.047	0.094	0.50
EAST	0.029	0.054	0.54
CENTRAL	-0.064	0.052	-1.24
WEST	-0.002	0.054	-0.29
NONMETRO	-0.070	0.053	-1.32
CONSTANT	1.679	0.132	12.75

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F2. Probit Coefficient Estimates for the Presence of Fruit Juice in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	3.39
HS1	-0.480	0.121	-3.96
HS2	-0.056	0.112	-0.50
HS3	0.217	0.113	1.91
AGEF25	-0.013	0.075	-0.17
AGEF50	0.042	0.070	0.61
AGEF65	0.049	0.092	0.54
CHILD0	-0.223	0.108	-2.07
EDUFH	0.028	0.067	0.42
EDUFCP	0.075	0.062	1.22
OTHER	0.230	0.081	2.85
UNEMP	0.019	0.069	0.28
PTEMP	-0.027	0.074	-0.37
HISPN	-0.069	0.124	-0.55
EAST	0.251	0.082	3.06
CENTRAL	0.052	0.071	0.74
WEST	-0.340	0.066	-5.13
NONMETRO	-0.132	0.067	-1.96
CONSTANT	1.741	0.169	10.31

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F3. Probit Coefficient Estimates for the Presence of Fruit Juice in the Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	1.65
HS1	-0.884	0.068	-12.93
HS2	-0.380	0.059	-6.45
HS3	-0.211	0.053	-3.98
AGEF25	0.046	0.043	1.06
AGEF50	0.048	0.042	1.15
AGEF65	-0.058	0.059	-0.99
CHILD0	-0.186	0.055	-3.36
EDUFH	-0.059	0.041	-1.44
EDUFCP	-0.060	0.037	-1.61
OTHER	0.358	0.045	7.99
UNEMP	-0.056	0.041	-1.38
PTEMP	-0.015	0.044	-0.33
HISPN	-0.012	0.068	-0.18
EAST	-0.153	0.043	-3.59
CENTRAL	0.077	0.042	1.82
WEST	0.130	0.044	2.94
NONMETRO	-0.128	0.045	-2.87
CONSTANT	0.575	0.096	5.99

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F4. Probit Coefficient Estimates for the Presence of Bottled Water in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	7.40
HS1	-0.197	0.067	-2.95
HS2	-0.127	0.058	-2.20
HS3	-0.056	0.052	-1.07
AGEF25	0.064	0.043	1.50
AGEF50	-0.120	0.041	-2.91
AGEF65	-0.402	0.059	-6.85
CHILD0	-0.117	0.054	-2.16
EDUFH	0.005	0.040	0.12
EDUFCP	-0.063	0.037	-1.71
OTHER	0.271	0.044	6.21
UNEMP	-0.088	0.040	-2.20
PTEMP	-0.012	0.043	-0.27
HISPN	-0.134	0.067	-2.00
EAST	0.060	0.042	1.41
CENTRAL	-0.048	0.041	-1.15
WEST	0.138	0.044	3.16
NONMETRO	-0.085	0.044	-1.91
CONSTANT	0.215	0.094	2.28

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F5. Probit Coefficient Estimates for the Presence of Bottled Water in the Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	3.28
HS1	-0.087	0.066	-1.32
HS2	0.060	0.057	1.05
HS3	-0.045	0.051	-0.88
AGEF25	0.013	0.042	0.32
AGEF50	-0.002	0.041	-0.58
AGEF65	-0.109	0.058	-1.88
CHILD0	-0.104	0.054	-1.95
EDUFH	-0.030	0.040	-0.75
EDUFCP	-0.079	0.036	-2.16
OTHER	0.242	0.042	5.70
UNEMP	0.022	0.040	0.55
PTEMP	0.031	0.043	0.73
HISPN	-0.012	0.064	-0.19
EAST	-0.087	0.042	-2.06
CENTRAL	-0.099	0.041	-2.41
WEST	0.038	0.043	0.89
NONMETRO	-0.093	0.044	-2.09
CONSTANT	-0.168	0.092	-1.83

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F6. Probit Coefficient Estimates for the Presence of Carbonated Soft Drinks in the Pint Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	4.42
HS1	-0.692	0.106	-6.52
HS2	-0.248	0.098	-2.53
HS3	-0.072	0.092	-0.79
AGEF25	-0.032	0.066	-0.48
AGEF50	-0.057	0.062	-0.92
AGEF65	-0.235	0.081	-2.89
CHILD0	-0.064	0.091	-0.70
EDUFH	0.164	0.062	2.66
EDUFCP	-0.059	0.053	-1.10
OTHER	-0.010	0.063	-0.15
UNEMP	-0.007	0.060	-0.11
PTEMP	0.073	0.067	1.09
HISPN	-0.041	0.110	-0.38
EAST	-0.435	0.058	-7.56
CENTRAL	0.016	0.063	0.25
WEST	0.166	0.070	2.38
NONMETRO	0.041	0.066	0.62
CONSTANT	1.662	0.151	11.03

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F7. Probit Coefficient Estimates for the Presence of Carbonated Soft Drinks in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	-1.03
HS1	-0.441	0.070	-6.31
HS2	-0.244	0.061	-4.00
HS3	0.011	0.056	0.19
AGEF25	-0.065	0.045	-1.45
AGEF50	-0.256	0.043	-5.93
AGEF65	-0.436	0.060	-7.33
CHILD0	0.034	0.058	0.60
EDUFH	0.007	0.042	0.16
EDUFCP	-0.143	0.038	-3.76
OTHER	0.034	0.045	0.76
UNEMP	-0.131	0.041	-3.18
PTEMP	0.012	0.045	0.26
HISPN	-0.080	0.069	-1.15
EAST	0.037	0.044	0.83
CENTRAL	-0.084	0.043	-1.96
WEST	-0.297	0.044	-6.74
NONMETRO	0.070	0.046	1.52
CONSTANT	1.045	0.099	10.58

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F8. Probit Coefficient Estimates for the Presence of Carbonated Soft Drinks in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	3.72
HS1	-0.794	0.127	-6.23
HS2	-0.353	0.118	-2.99
HS3	-0.021	0.114	-0.18
AGEF25	0.068	0.077	0.89
AGEF50	-0.016	0.069	-0.23
AGEF65	0.077	0.091	0.85
CHILD0	-0.047	0.110	-0.42
EDUFH	0.005	0.066	0.78
EDUFCP	0.005	0.061	0.84
OTHER	0.303	0.084	3.63
UNEMP	-0.057	0.067	-0.85
PTEMP	-0.059	0.074	-0.79
HISPN	-0.104	0.134	-0.78
EAST	0.180	0.078	2.32
CENTRAL	0.029	0.069	0.43
WEST	-0.227	0.067	-3.37
NONMETRO	-0.131	0.067	-1.96
CONSTANT	1.885	0.177	10.63

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F9. Probit Coefficient Estimates for the Presence of Flavored Milk in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	-1.11
HS1	-0.340	0.074	-4.57
HS2	-0.225	0.063	-3.60
HS3	0.013	0.054	0.25
AGEF25	-0.021	0.045	-0.46
AGEF50	-0.260	0.047	-5.59
AGEF65	-0.418	0.069	-6.03
CHILD0	-0.135	0.058	-2.33
EDUFH	0.125	0.045	2.79
EDUFCP	-0.012	0.042	-0.29
OTHER	-0.197	0.050	-3.94
UNEMP	-0.017	0.045	-0.39
PTEMP	-0.054	0.048	-1.12
HISPN	-0.170	0.070	-2.42
EAST	-0.165	0.049	-3.39
CENTRAL	0.113	0.046	2.49
WEST	-0.122	0.050	-2.46
NONMETRO	0.046	0.049	0.94
CONSTANT	-0.191	0.102	-1.87

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F10. Probit Coefficient Estimates for the Presence of Flavored Milk in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	-0.71
HS1	-0.693	0.084	-8.25
HS2	-0.425	0.068	-6.26
HS3	-0.184	0.059	-3.12
AGEF25	-0.026	0.051	-0.52
AGEF50	-0.187	0.052	-3.61
AGEF65	-0.311	0.077	-4.02
CHILD0	-0.025	0.064	-0.39
EDUFH	0.102	0.049	2.08
EDUFCP	-0.059	0.047	-1.27
OTHER	-0.387	0.061	-6.35
UNEMP	0.007	0.049	0.14
PTEMP	-0.029	0.053	-0.55
HISPN	0.024	0.084	0.28
EAST	-0.181	0.055	-3.32
CENTRAL	0.202	0.049	4.09
WEST	-0.364	0.059	-6.13
NONMETRO	0.250	0.052	4.76
CONSTANT	-0.572	0.117	-4.91

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F11. Probit Coefficient Estimates for the Presence of White Milk in the Quart Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	5.29
HS1	0.739	0.069	10.64
HS2	0.449	0.060	7.44
HS3	0.199	0.055	3.62
AGEF25	-0.118	0.044	-2.66
AGEF50	-0.006	0.042	-0.13
AGEF65	0.134	0.059	2.27
CHILD0	0.135	0.056	2.39
EDUFH	-0.006	0.042	-0.15
EDUFCP	-0.016	0.038	-0.41
OTHER	0.395	0.044	9.02
UNEMP	-0.020	0.041	-0.49
PTEMP	0.050	0.045	1.13
HISPN	0.041	0.068	0.61
EAST	0.515	0.043	11.98
CENTRAL	-0.188	0.043	-4.34
WEST	0.153	0.044	3.47
NONMETRO	-0.045	0.046	-0.98
CONSTANT	-1.126	0.097	-11.60

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F12. Probit Coefficient Estimates for the Presence of White Milk in the Half-Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	2.74
HS1	0.139	0.071	1.94
HS2	0.300	0.062	4.83
HS3	0.197	0.055	3.57
AGEF25	-0.012	0.045	-0.27
AGEF50	0.068	0.045	1.52
AGEF65	0.086	0.063	1.36
CHILD0	0.043	0.058	0.74
EDUFH	0.039	0.044	0.88
EDUFCP	-0.026	0.040	-0.65
OTHER	0.055	0.047	1.18
UNEMP	0.047	0.043	1.09
PTEMP	0.073	0.047	1.57
HISPN	0.032	0.070	0.46
EAST	0.094	0.048	1.97
CENTRAL	-0.314	0.044	-7.13
WEST	-0.249	0.046	-5.38
NONMETRO	0.121	0.048	2.55
CONSTANT	0.387	0.100	3.88

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

Table F13. Probit Coefficient Estimates for the Presence of White Milk in the Gallon Size

Coefficient	Coefficient Estimate	Standard Error	t-statistic
AVGINC	0.000	0.000	-2.26
HS1	-1.282	0.082	-15.59
HS2	-0.604	0.074	-8.18
HS3	-0.295	0.071	-4.15
AGEF25	0.071	0.053	1.35
AGEF50	-0.097	0.047	-2.04
AGEF65	-0.104	0.065	-1.60
CHILD0	-0.364	0.068	-5.32
EDUFH	0.084	0.048	1.74
EDUFCP	-0.054	0.042	-1.27
OTHER	-0.455	0.048	-9.41
UNEMP	0.017	0.047	0.36
PTEMP	0.058	0.052	1.11
HISPN	-0.167	0.080	-2.07
EAST	-0.452	0.047	-9.54
CENTRAL	0.289	0.051	5.67
WEST	-0.174	0.049	-3.53
NONMETRO	-0.024	0.052	-0.46
CONSTANT	2.024	0.117	17.27

See sub-section, Estimation of the Probit Model (Selection Stage), pages 95-96 for an explanation of the coefficients.

APPENDIX G

COMPARISON OF THE THREE AIDS MODELS, CHAPTER V

Three Model Comparisons

The comparison of all three models, the CLA/AIDS, NLAIDS, and CNLAIDS models, for own-price elasticities both uncompensated and compensated as well as the expenditure elasticities can be seen in table on the next page. Any p-values less than .05 were considered statistically significant. In a comparison of only the censored models, CLA/AIDS and CNLAIDS, the first eight products in the models, which were all non-milk products, and fruit juices in all three sizes, bottled water, in both sizes, and CSDs in all three sizes, were all statistically different from zero and have like signs for comparable elasticities. The uncompensated and compensated elasticities were negative and the expenditure elasticities were positive for these eight products. The magnitudes of the uncompensated and compensated elasticities appeared close in magnitude, but in fourteen of the sixteen estimates from the CLA/AIDS model were smaller in absolute terms. Although the expenditure elasticities were positively signed for these eight products they were only close in one case, fruit juices in the quart size (FJQ). Of the remaining seven, six were classed oppositely between normal or luxury good status; the only exception was CSDs in the pint size (CSDP), which was classified by both models as a luxury.

The elasticity estimates for white milk in the quart size (WMQ) were negative and statistically significant, but the magnitudes were greater than five for both the compensated and uncompensated elasticities associated with the CLA/AIDS model. These same elasticity estimates for the CNLAIDS were positive, not statistically significant and less than 0.9. Additionally, the expenditure elasticity estimates were of opposite sign. The LA/AIDS model expenditure elasticity was statistically insignificant and less than 0.12. The CNLAIDS model expenditure elasticity was negative, statistically different from zero and had a magnitude of over 3.75.

Table G1. Own-price, Cross-price and Expenditure Elasticity Comparison of All Three AIDS Models

	Uncompensated Elasticities			Compensated Elasticities			Expenditure Elasticities		
Products	CLA/AIDS	CNLAIDS	NLAIDS	CLA/AIDS	CNLAIDS	NLAIDS	CLA/AIDS	CNLAIDS	NLAIDS
FMQ	-1.471	-1.5335	-1.52	-1.4164	-1.4789	-1.4529	0.804	0.8025	0.9863
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FJH	-0.4584	-0.5189	-0.52404	-0.3351	-0.3637	-0.3703	0.8312	1.0460	1.0362
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FJG	-0.4197	-0.6110	-0.74985	-0.3837	-0.5598	-0.7023	0.920	1.3107	1.2181
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BWH	-2.9952	-3.1251	-2.1888	-2.9740	-3.1142	-2.1727	1.0954	0.5650	0.8337
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BWG	-1.2579	-1.6054	-1.2633	-1.2414	-1.5986	-1.2520	1.036	0.4297	0.7065
p-value	0.002	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
CSDP	-1.2206	-1.2102	-1.0993	-0.8444	-0.9437	-0.8472	1.6082	1.1395	1.0778
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CSDQ	-2.3719	-2.5128	-2.0393	-2.3227	-2.4788	-2.0040	1.272	0.8801	0.9116
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CSDH	-0.5797	-0.6090	-0.6578	-0.4301	-0.4220	-0.4714	0.8933	1.1166	1.1133
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WMQ	-5.2857	0.8964	-0.87553	-5.2845	0.8563	-0.8876	0.110	-3.7558	-1.1332
p-value	0.000	0.214	0.02781	0.000	0.235	0.026	0.457	0.000	0.000
WMH	0.0562	-2.0015	0.1517	0.0665	-1.9930	-0.0599	0.1702	0.1408	0.9966
p-value	0.679	0.000	0.50728	0.624	0.000	0.651	0.000	0.000	0.000
WMG	-0.9669	-0.5723	-0.61675	-0.8164	-0.3162	-0.4014	0.793	1.3498	1.1349
p-value	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000
FMQ	3.1559	2.7078	-1.9511	3.1591	2.7101	-12.5030	0.958	0.6742	1.2414
p-value	0.004	0.026	0.000	0.004	0.026	0.000	0.000	0.000	0.000
FMH	0.3289	2.3078	-0.042055	0.3370	2.3145	-0.1476	1.7072	1.4225	0.2942
p-value	0.827	0.196	0.02247	0.823	0.195	0.687	0.000	0.000	0.000

See Table 33 for a complete explanation of the acronyms (Page 102).

White milk in the half-gallon size (WMH) had opposite signs in the two models. However, in this case it was the CLA/AIDS model, which estimated the positive, statistically insignificant value for both the compensated and uncompensated elasticities, with values less than 0.07. The CNLAIDS model estimated statistically significant values close to -2 for both the compensated and uncompensated elasticities. Both the CLA/AIDS and CNLAIDS models estimated a value that was close in magnitude and positively significant for the expenditure elasticity estimates. The CNLAIDS value was close to 0.14, and the LA/AIDS was close 0.17.

White milk in the gallon size (WMG) for both models, and both elasticities were negative and statistically significant. All four elasticities were less than one in magnitude and inelastic. The expenditure elasticities, although signed the same, and statistically significant were classified differently. The CNLAIDS model classed WMG as a luxury, and the CLA/AIDS classified it as a normal good.

The remaining two products were flavored milks, one in the quart size (FMQ) and the other in the half-gallon size (FMH). These two beverages made up less than one percent of the average budget share, which may, in part explain the following results. Both models estimated compensated and uncompensated elasticities for FMH and FMQ as positive. However, the FMH estimates for both the compensated and uncompensated elasticities were not statistically different from zero, but were nearly seven times greater for the CNLAIDS model, than they were for the CLA/AIDS model. All of the quantity elasticity estimates for FMQ were statistically significant and were close to 3 for both the CNLAIDS and CLA/AIDS models. FMH milk was classified as a luxury good by both models and FMQ was classed as a normal good by both models. However, the expenditure elasticity estimates for the CLA/AIDS model were greater in magnitude than those of the CNLAIDS.

The remaining tables show the complete elasticity matrices for the CLA/AIDS and NLAIDS models for uncompensated, compensated and expenditure elasticities.

Table G2. Uncompensated Elasticities of the CLA/AIDS Model

Products	FJQ	FJH	FJG	BWH	BWG	CSDP	CSDQ	CSDH	WMQ	WMH	WMG	FMQ	FMH	η_i
FJQ	-1.4710	-0.0196	0.0736	0.0863	0.0214	0.3728	0.0969	-0.0033	0.0805	0.2225	-0.2437	-0.0014	-0.0188	0.8039
p-value	0.000	0.436	0.041	0.001	0.429	0.000	0.003	0.915	0.008	0.000	0.001	0.854	0.093	0.000
FJH	0.0319	-0.4584	0.0340	0.0397	0.0290	-0.0345	-0.0698	0.0257	-0.0638	-0.0367	-0.2885	-0.0171	-0.0227	0.8312
p-value	0.051	0.000	0.011	0.001	0.036	0.118	0.000	0.178	0.000	0.094	0.000	0.008	0.008	0.000
FJG	-0.0421	0.1159	-0.4197	0.0137	-0.2318	-0.1693	0.0174	-0.2920	-0.2169	-0.3381	0.7153	0.0093	-0.0820	0.9203
p-value	0.334	0.022	0.000	0.797	0.000	0.022	0.782	0.000	0.001	0.000	0.000	0.656	0.004	0.000
BWH	0.2836	0.2652	0.0208	-2.9952	-0.2710	0.4388	0.3817	0.1471	-0.6760	-0.3435	1.4563	0.0683	0.1285	1.0954
p-value	0.001	0.003	0.847	0.000	0.062	0.006	0.007	0.248	0.000	0.104	0.000	0.156	0.061	0.000
BWG	0.0754	0.2396	-0.5723	-0.3277	-1.2579	-0.1003	0.8056	0.1803	-1.4085	0.1645	1.2989	-0.0193	-0.1141	1.0356
p-value	0.509	0.063	0.000	0.063	0.002	0.708	0.001	0.405	0.000	0.643	0.007	0.865	0.482	0.000
CSDP	0.0537	-0.1372	-0.0551	0.0264	-0.0160	-1.2206	0.1302	-0.1496	0.0415	-0.0223	-0.2590	0.0021	-0.0023	1.6082
p-value	0.000	0.000	0.000	0.052	0.388	0.000	0.000	0.000	0.000	0.228	0.000	0.425	0.545	0.000
CSDQ	0.1386	-0.3330	0.0038	0.1875	0.3283	0.8660	-2.3719	-0.3629	-0.1753	-0.2037	0.5995	0.0307	0.0202	1.2723
p-value	0.017	0.000	0.952	0.008	0.001	0.000	0.000	0.000	0.014	0.063	0.000	0.104	0.455	0.000
CSDH	-0.0074	0.0136	-0.0670	0.0209	0.0194	-0.0417	-0.0692	-0.5797	-0.0136	-0.0582	-0.1321	0.0090	0.0127	0.8933
p-value	0.553	0.421	0.000	0.151	0.343	0.022	0.000	0.000	0.264	0.000	0.000	0.119	0.091	0.000
WMQ	0.5604	-0.7803	-0.7621	-1.2071	-2.0904	1.2598	-0.5908	-0.0821	-5.2857	1.7452	6.5942	0.0103	0.5186	0.1101
p-value	0.003	0.000	0.002	0.000	0.000	0.000	0.022	0.669	0.000	0.005	0.000	0.956	0.054	0.457
WMH	0.2928	0.0083	-0.1885	-0.0917	0.0571	0.2503	-0.0873	-0.0396	0.3065	0.0562	-0.6774	0.0105	-0.0673	0.1702
p-value	0.000	0.878	0.001	0.174	0.541	0.000	0.212	0.395	0.005	0.679	0.000	0.538	0.006	0.000
WMG	-0.0866	-0.2199	0.1522	0.1543	0.1130	-0.1286	0.1407	-0.0998	0.3634	-0.2541	-0.9669	-0.0166	0.0558	0.7930
p-value	0.001	0.000	0.000	0.000	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.442	0.152	0.000
FMQ	-0.0396	-0.7711	0.1061	0.3941	-0.0899	0.2964	0.3639	0.4337	0.0234	0.1401	-0.9619	3.1559	-4.0087	0.9576
p-value	0.801	0.007	0.661	0.152	0.867	0.112	0.092	0.130	0.969	0.646	0.431	0.004	0.000	0.000
FMH	-0.3305	-0.8414	-0.7059	0.5126	-0.3944	-0.1355	0.1481	0.3123	1.1495	-0.9533	2.0574	-2.8550	0.3289	1.7072
p-value	0.038	0.002	0.003	0.067	0.470	0.488	0.503	0.245	0.058	0.002	0.192	0.000	0.827	0.000

* See Table 33 for a complete explanation of the acronyms (Page 101).

Table G3. Compensated Elasticity of the CLA/AIDS Model

Products	FJQ	FJH	FJG	BWH	BWG	CSDP	CSDQ	CSDH	WMQ	WMH	WMG	FMQ	FMH
FJQ	-1.4164	0.1929	0.0118	0.1019	0.0342	0.5608	0.1280	0.1313	0.0891	0.2713	-0.0911	0.0013	-0.0149
p-value	0.000	0.000	0.639	0.000	0.205	0.000	0.000	0.000	0.003	0.000	0.214	0.872	0.181
FJH	0.0884	-0.3351	0.0664	0.0558	0.0423	0.1600	-0.0376	0.1649	-0.0549	0.0137	-0.1308	-0.0143	-0.0188
p-value	0.000	0.000	0.000	0.000	0.002	0.000	0.011	0.000	0.000	0.532	0.000	0.026	0.029
FJG	0.0205	0.2524	-0.3837	0.0315	-0.2172	0.0459	0.0530	-0.1379	-0.2070	-0.2823	0.8900	0.0124	-0.0776
p-value	0.639	0.000	0.000	0.553	0.000	0.552	0.399	0.035	0.002	0.002	0.000	0.552	0.006
BWH	0.3581	0.4277	0.0636	-2.9740	-0.2535	0.6951	0.4241	0.3305	-0.6643	-0.2771	1.6641	0.0720	0.1337
p-value	0.000	0.000	0.553	0.000	0.081	0.000	0.003	0.009	0.000	0.190	0.000	0.134	0.051
BWG	0.1459	0.3932	-0.5318	-0.3076	-1.2414	0.1420	0.8457	0.3537	-1.3975	0.2273	1.4955	-0.0158	-0.1092
p-value	0.205	0.002	0.000	0.081	0.002	0.601	0.000	0.100	0.000	0.522	0.002	0.889	0.501
CSDP	0.1631	0.1015	0.0077	0.0575	0.0097	-0.8444	0.1924	0.1198	0.0586	0.0752	0.0462	0.0075	0.0053
p-value	0.000	0.000	0.552	0.000	0.601	0.000	0.000	0.000	0.000	0.000	0.157	0.004	0.155
CSDQ	0.2251	-0.1442	0.0535	0.2122	0.3486	1.1636	-2.3227	-0.1499	-0.1618	-0.1266	0.8409	0.0350	0.0263
p-value	0.000	0.011	0.399	0.003	0.000	0.000	0.000	0.024	0.024	0.249	0.000	0.064	0.333
CSDH	0.0533	0.1461	-0.0322	0.0382	0.0337	0.1673	-0.0346	-0.4301	-0.0041	-0.0040	0.0374	0.0120	0.0169
p-value	0.000	0.000	0.035	0.009	0.100	0.000	0.024	0.000	0.739	0.809	0.175	0.037	0.024
WMQ	0.5679	-0.7639	-0.7578	-1.2050	-2.0887	1.2855	-0.5865	-0.0637	-5.2845	1.7519	6.6151	0.0106	0.5191
p-value	0.003	0.000	0.002	0.000	0.000	0.000	0.024	0.739	0.000	0.005	0.000	0.955	0.054
WMH	0.3044	0.0335	-0.1818	-0.0885	0.0598	0.2901	-0.0808	-0.0111	0.3083	0.0665	-0.6451	0.0110	-0.0665
p-value	0.000	0.532	0.002	0.190	0.522	0.000	0.249	0.809	0.005	0.624	0.000	0.516	0.007
WMG	-0.0327	-0.1023	0.1831	0.1697	0.1257	0.0570	0.1714	0.0330	0.3719	-0.2061	-0.8164	-0.0139	0.0595
p-value	0.214	0.000	0.000	0.000	0.002	0.157	0.000	0.175	0.000	0.000	0.000	0.519	0.127
FMQ	0.0256	-0.6291	0.1435	0.4126	-0.0746	0.5204	0.4010	0.5940	0.0336	0.1982	-0.7802	3.1591	-4.0041
p-value	0.872	0.026	0.552	0.134	0.889	0.004	0.064	0.037	0.955	0.516	0.519	0.004	0.000
FMH	-0.2144	-0.5881	-0.6392	0.5457	-0.3672	0.2639	0.2142	0.5982	1.1677	-0.8498	2.3814	-2.8493	0.3370
p-value	0.181	0.029	0.006	0.051	0.501	0.155	0.333	0.024	0.054	0.007	0.127	0.000	0.823

* See Table 33 for a complete explanation of the acronyms (Page 101).

Table G4. Uncompensated Elasticities of the NLAIDS Model

Products	FJQ	FJH	FJG	BWH	BWG	CSDP	CSDQ	CSDH	Products	WMH	WMG	FMQ	FMH	N_i
FJQ	-1.5200	0.0783	-0.0739	0.0363	-0.0206	0.2386	0.0932	-0.0182	0.0362	0.2710	-0.1034	0.0004	-0.0044	0.9863
p-value	0.000	0.011	0.000	0.077	0.348	0.000	0.001	0.480	0.151	0.000	0.032	0.942	0.594	0.000
FJH	0.0325	-0.5240	0.0162	0.0253	0.0037	-0.0473	-0.0654	-0.0364	-0.0742	-0.0777	-0.2545	-0.0165	-0.0180	1.0362
p-value	0.020	0.000	0.228	0.028	0.784	0.044	0.000	0.043	0.000	0.001	0.000	0.008	0.030	0.000
FJG	-0.1444	0.0345	-0.7499	0.0165	-0.0817	0.0176	0.0731	-0.2504	0.1457	0.0024	-0.2506	0.0033	-0.0341	1.2181
p-value	0.000	0.499	0.000	0.620	0.044	0.736	0.063	0.000	0.003	0.972	0.001	0.834	0.121	0.000
BWH	0.1379	0.2237	0.0479	-2.1888	-0.1437	0.5703	0.2429	0.0495	-0.0640	0.1206	0.0088	0.0504	0.1109	0.8337
p-value	0.056	0.011	0.475	0.000	0.081	0.000	0.003	0.483	0.491	0.334	0.956	0.068	0.004	0.000
BWG	-0.0689	0.0830	-0.1810	-0.1719	-1.2633	0.1510	0.2695	0.3755	-0.1480	0.1963	0.0154	0.0113	0.0245	0.7065
p-value	0.460	0.512	0.069	0.085	0.000	0.254	0.014	0.000	0.331	0.248	0.943	0.831	0.736	0.000
CSDP	0.0632	-0.0361	0.0085	0.0425	0.0045	-1.0993	0.0906	-0.0080	0.0016	-0.0553	-0.0927	0.0002	0.0025	1.0778
p-value	0.000	0.016	0.337	0.000	0.621	0.000	0.000	0.565	0.884	0.007	0.001	0.948	0.475	0.000
CSDQ	0.1690	-0.2323	0.0855	0.1200	0.1078	0.5864	-2.0393	-0.1474	-0.1684	-0.1738	0.7188	0.0294	0.0327	0.9116
p-value	0.001	0.000	0.031	0.003	0.017	0.000	0.000	0.001	0.001	0.027	0.000	0.029	0.091	0.000
CSDH	-0.0159	-0.0437	-0.0543	0.0004	0.0294	-0.0197	-0.0417	-0.6578	-0.0214	-0.0624	-0.2360	0.0031	0.0066	1.1133
p-value	0.121	0.006	0.000	0.962	0.003	0.290	0.000	0.000	0.136	0.006	0.000	0.589	0.382	0.000
WMQ	0.3741	-0.7124	0.6206	-0.0780	-0.1930	0.5477	-0.5320	0.0318	-0.8755	1.0501	0.4254	0.1462	0.3283	-1.1332
p-value	0.020	0.001	0.001	0.643	0.396	0.025	0.004	0.886	0.028	0.006	0.280	0.109	0.011	0.000
WMH	0.3511	-0.0825	0.0337	0.0499	0.0592	-0.0369	-0.0862	-0.0435	0.1760	-0.0778	-0.6212	0.0262	-0.0421	0.2942
p-value	0.000	0.135	0.426	0.210	0.185	0.643	0.085	0.481	0.009	0.558	0.000	0.049	0.022	0.000
WMG	-0.0471	-0.2133	-0.0477	-0.0050	-0.0056	-0.1267	0.1378	-0.2107	-0.0011	-0.2486	-0.6168	0.2338	0.0161	1.1349
p-value	0.008	0.000	0.003	0.756	0.759	0.000	0.000	0.000	0.962	0.000	0.000	0.000	0.048	0.000
FMQ	0.0022	-0.6829	0.1022	0.2650	0.0186	0.1475	0.3114	0.2969	0.2925	0.1517	13.3380	-12.5060	-2.7333	0.9966
p-value	0.985	0.013	0.578	0.094	0.941	0.382	0.044	0.298	0.313	0.507	0.000	0.000	0.000	0.000
FMH	-0.0797	-0.5934	-0.2816	0.4445	0.0739	0.0877	0.2539	0.2131	0.7137	-0.5900	0.6210	-1.9511	-0.1534	1.2414
p-value	0.495	0.022	0.120	0.005	0.761	0.616	0.108	0.426	0.014	0.012	0.057	0.000	0.675	0.000

* See Table 33 for a complete explanation of the acronyms (Page 101).

Table G5. Compensated Elasticities of the NLAIDS Model

Products	FJQ	FJH	FJG	BWH	BWG	CSDP	CSDQ	CSDH	Products	WMH	WMG	FMQ	FMH
FJQ	-1.4529	0.2246	-0.0354	0.0554	-0.0049	0.4694	0.1314	0.1470	0.0467	0.3308	0.0838	0.0038	0.0003
p-value	0.000	0.000	0.084	0.007	0.824	0.000	0.000	0.000	0.064	0.000	0.090	0.532	0.969
FJH	0.1030	-0.3703	0.0566	0.0453	0.0202	0.1951	-0.0253	0.1372	-0.0631	-0.0149	-0.0579	-0.0130	-0.0131
p-value	0.000	0.000	0.000	0.000	0.137	0.000	0.082	0.000	0.000	0.510	0.057	0.038	0.115
FJG	-0.0615	0.2152	-0.7023	0.0400	-0.0623	0.3025	0.1202	-0.0464	0.1587	0.0762	-0.0194	0.0074	-0.0284
p-value	0.085	0.000	0.000	0.228	0.125	0.000	0.002	0.276	0.001	0.248	0.805	0.640	0.198
BWH	0.1946	0.3474	0.0805	-2.1727	-0.1304	0.7654	0.2751	0.1892	-0.0551	0.1712	0.1670	0.0532	0.1148
p-value	0.007	0.000	0.230	0.000	0.113	0.000	0.001	0.007	0.553	0.170	0.295	0.054	0.003
BWG	-0.0209	0.1878	-0.1534	-0.1582	-1.2520	0.3163	0.2968	0.4939	-0.1405	0.2391	0.1495	0.0137	0.0278
p-value	0.823	0.138	0.123	0.113	0.000	0.017	0.007	0.000	0.356	0.159	0.492	0.796	0.701
CSDP	0.1365	0.1238	0.0506	0.0633	0.0216	-0.8472	0.1323	0.1725	0.0131	0.0101	0.1118	0.0038	0.0077
p-value	0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.000	0.244	0.627	0.000	0.125	0.031
CSDQ	0.2310	-0.0971	0.1211	0.1377	0.1223	0.7997	-2.0040	0.0053	-0.1586	-0.1185	0.8918	0.0325	0.0370
p-value	0.000	0.082	0.002	0.001	0.007	0.000	0.000	0.908	0.002	0.131	0.000	0.016	0.056
CSDH	0.0598	0.1215	-0.0108	0.0219	0.0472	0.2408	0.0013	-0.4714	-0.0095	0.0051	-0.0247	0.0069	0.0119
p-value	0.000	0.000	0.277	0.007	0.000	0.000	0.900	0.000	0.506	0.822	0.320	0.233	0.116
WMQ	0.2970	-0.8806	0.5763	-0.0999	-0.2111	0.2826	-0.5758	-0.1580	-0.8876	0.9814	0.2104	0.1423	0.3230
p-value	0.065	0.000	0.001	0.553	0.353	0.254	0.002	0.482	0.026	0.010	0.594	0.118	0.012
WMH	0.3711	-0.0389	0.0452	0.0556	0.0639	0.0319	-0.0749	0.0057	0.1792	-0.0599	-0.5654	0.0272	-0.0407
p-value	0.000	0.482	0.287	0.163	0.153	0.689	0.135	0.927	0.008	0.651	0.000	0.041	0.027
WMG	0.0301	-0.0449	-0.0034	0.0169	0.0125	0.1388	0.1817	-0.0206	0.0110	-0.1798	-0.4014	0.2376	0.0215
p-value	0.090	0.059	0.832	0.298	0.495	0.000	0.000	0.348	0.619	0.000	0.000	0.000	0.008
FMQ	0.0700	-0.5351	0.1411	0.2843	0.0345	0.3806	0.3500	0.4638	0.3032	0.2121	13.5270	-12.5030	-2.7286
p-value	0.565	0.051	0.442	0.073	0.891	0.024	0.024	0.104	0.296	0.354	0.000	0.000	0.000
FMH	0.0047	-0.4092	-0.2331	0.4685	0.0937	0.3781	0.3020	0.4210	0.7269	-0.5147	0.8566	-1.9469	-0.1476
p-value	0.968	0.115	0.199	0.003	0.700	0.031	0.056	0.116	0.012	0.029	0.009	0.000	0.687

* See Table 33 for a complete explanation of the acronyms (Page 101).

APPENDIX H

COEFFICIENT ESTIMATES FROM THE CNLAIDS MODEL

Table H1. Coefficient Estimates From the CNLAIDS Model

Coefficient	Coefficient Estimate	Standard Error	t-statistic
a_{0}	-3.7150	0.9857	-3.77
a_{1}	0.2538	0.0187	13.60
a_{2}	0.0659	0.0142	4.65
a_{3}	-0.0775	0.0155	-5.01
a_{4}	0.1334	0.0124	10.78
a_{5}	0.1149	0.0202	5.68
a_{6}	-0.1456	0.0518	-2.81
a_{7}	0.0605	0.0158	3.82
a_{8}	-0.0021	0.0154	-0.13
a_{9}	0.5188	0.0472	11.00
a_{10}	0.5826	0.0526	11.09
a_{11}	0.0267	0.0214	1.25
a_{12}	0.0192	0.0108	1.78
$?_{1\,1}$	-0.0392	0.0034	-11.45
$?_{1\,2}$	0.0075	0.0025	3.01
$?_{1\,3}$	-0.0021	0.0017	-1.25
$?_{1\,4}$	0.0052	0.0017	2.97
$?_{1\,5}$	0.0000	0.0018	0.02
$?_{1\,6}$	0.0221	0.0039	5.64
$?_{1\,7}$	0.0045	0.0023	1.92
$?_{1\,8}$	0.0031	0.0023	1.37
$?_{1\,9}$	-0.0045	0.0021	-2.16
$?_{1\,10}$	0.0130	0.0035	3.75
$?_{1\,11}$	-0.0005	0.0008	-0.68
$?_{1\,12}$	-0.0002	0.0005	-0.29
$?_{2\,2}$	0.0719	0.0037	19.40
$?_{2\,3}$	0.0047	0.0020	2.31
$?_{2\,4}$	0.0041	0.0018	2.35
$?_{2\,5}$	0.0020	0.0022	0.92
$?_{2\,6}$	-0.0049	0.0037	-1.30
$?_{2\,7}$	-0.0098	0.0022	-4.43
$?_{2\,8}$	-0.0058	0.0030	-1.96
$?_{2\,9}$	-0.0117	0.0023	-4.98
$?_{2\,10}$	-0.0078	0.0034	-2.29
$?_{2\,11}$	-0.0030	0.0013	-2.33
$?_{2\,12}$	-0.0028	0.0010	-2.83

Table H1. Continued

$?_{3\,3}$	0.0142	0.0029	4.89
$?_{3\,4}$	0.0015	0.0022	0.68
$?_{3\,5}$	-0.0062	0.0027	-2.32
$?_{3\,6}$	0.0010	0.0037	0.27
$?_{3\,7}$	0.0043	0.0026	1.66
$?_{3\,8}$	-0.0210	0.0028	-7.39
$?_{3\,9}$	0.0121	0.0029	4.15
$?_{3\,10}$	0.0049	0.0040	1.23
$?_{3\,11}$	-0.0019	0.0014	-1.39
$?_{3\,12}$	0.0005	0.0010	0.54
$?_{4\,4}$	-0.0420	0.0034	-12.38
$?_{4\,5}$	-0.0055	0.0029	-1.90
$?_{4\,6}$	0.0220	0.0037	6.02
$?_{4\,7}$	0.0047	0.0027	1.73
$?_{4\,8}$	-0.0012	0.0026	-0.48
$?_{4\,9}$	-0.0015	0.0031	-0.49
$?_{4\,10}$	0.0009	0.0043	0.21
$?_{4\,11}$	0.0031	0.0013	2.42
$?_{4\,12}$	0.0013	0.0009	1.44
$?_{5\,5}$	-0.0106	0.0068	-1.57
$?_{5\,6}$	0.0077	0.0050	1.56
$?_{5\,7}$	0.0061	0.0039	1.56
$?_{5\,8}$	0.0037	0.0038	0.98
$?_{5\,9}$	-0.0061	0.0049	-1.25
$?_{5\,10}$	0.0146	0.0062	2.35
$?_{5\,11}$	-0.0004	0.0021	-0.19
$?_{5\,12}$	-0.0015	0.0015	-0.98
$?_{6\,6}$	-0.0528	0.0089	-5.92
$?_{6\,7}$	0.0273	0.0030	9.06
$?_{6\,8}$	-0.0043	0.0035	-1.22
$?_{6\,9}$	0.0086	0.0023	3.73
$?_{6\,10}$	0.0195	0.0051	3.81
$?_{6\,11}$	-0.0005	0.0007	-0.70
$?_{6\,12}$	0.0004	0.0006	0.76
$?_{7\,7}$	-0.0588	0.0040	-14.70
$?_{7\,8}$	-0.0066	0.0026	-2.53
$?_{7\,9}$	-0.0019	0.0025	-0.75
$?_{7\,10}$	0.0052	0.0043	1.23
$?_{7\,11}$	0.0013	0.0011	1.23
$?_{7\,12}$	0.0010	0.0007	1.40
$?_{8\,8}$	0.0650	0.0034	19.18

Table H1. Continued

?$_{8\ 9}$	0.0058	0.0021	2.79
?$_{8\ 10}$	0.0025	0.0032	0.78
?$_{8\ 11}$	0.0014	0.0013	1.03
?$_{8\ 12}$	0.0016	0.0010	1.55
?$_{9\ 9}$	-0.0068	0.0079	-0.86
?$_{9\ 10}$	-0.0192	0.0066	-2.90
?$_{9\ 11}$	-0.0029	0.0018	-1.57
?$_{9\ 12}$	-0.0020	0.0013	-1.54
?$_{10\ 10}$	-0.0904	0.0136	-6.65
?$_{10\ 11}$	-0.0025	0.0015	-1.68
?$_{10\ 12}$	0.0006	0.0010	0.57
?$_{11\ 11}$	0.0157	0.0085	1.86
?$_{11\ 12}$	-0.0067	0.0041	-1.63
?$_{12\ 12}$	0.0125	0.0041	3.04
ß$_{1}$	-0.0134	0.0011	-12.71
ß$_{2}$	0.0068	0.0016	4.16
ß$_{3}$	0.0121	0.0010	12.23
ß$_{4}$	-0.0084	0.0007	-11.71
ß$_{5}$	-0.0091	0.0010	-8.97
ß$_{6}$	0.0326	0.0028	11.78
ß$_{7i}$	-0.0046	0.0016	-2.92
ß$_{8}$	0.0195	0.0017	11.75
ß$_{9}$	-0.0507	0.0014	-35.50
ß$_{10}$	-0.0521	0.0023	-23.15
ß$_{11}$	0.0020	0.0015	1.31
ß$_{12}$	-0.0011	0.0006	-1.74
f_{1}	-0.0546	0.0089	-6.13
f_{2}	0.1081	0.0161	6.70
f_{3}	0.0417	0.0054	7.71
f_{4}	0.0128	0.0069	1.85
f_{5}	0.0211	0.0143	1.48
f_{6}	0.3078	0.0256	12.04
f_{7}	0.1196	0.0132	9.04
f_{8}	0.0456	0.0163	2.79
f_{9}	-0.0091	0.0162	-0.56
f_{10}	-0.0678	0.0239	-2.83
f_{11}	-0.0168	0.0124	-1.36
f_{12}	0.0110	0.0090	1.22

See Equation 5-9, page 95, for parameter explanations

VITA

Matthew C. Stockton

Field Specialization:

Agricultural Business, Marketing, Applied Micro Economics and Demand Analysis

Education:

Ph.D. Agricultural Economics, Texas A&M University, College Station, TX, 2004
M.S. Agricultural Economics, Texas A&M University, College Station, TX, 1987
B.S. Agricultural Business, California State University Fresno, Fresno CA, 1983

Professional Experience:

Summer Internship, USDA-ERS	July 14, 2004 – August 15, 2004
Research Assistant/Teaching Assistant/Lecturer	
Texas A&M University	2001 to current
Vo-Ag High School Instructor	1994 – 2000

Publications

Stockton M. C. “Impacts of Sample Size and Quality-Adjusted Imputed Prices on Own-Price Elasticities Estimated Using Cross-Sectional Data.” *Journal of Applied Agricultural Economics*, 35, 2(August 2003):415-421.

Anderson D., M. Haigh, M. Stockton, and R. Schwart. “Milk Pricing,” *Balanced Dairying Economics*, 21, 2, (June, 2001).

Anderson D., M. Haigh, M. Stockton, and R. Schwart. “Milk Pricing,” Extension Fact Sheet, RM2-41.0, L5403, Texas A&M University, August 2001.

Rister M. E., M. Stockton. J.W. Richardson, G. M. Perry and D. A. Bessler. “Identifying Threshold Technical Advances Required for Incorporating Alternative Crops Into Current Crop Mixes.” Abstract published in the *American Journal of Agricultural Economics* 69, 5 (1987):1096.

Stockton M. “Economics of Crop Rotations in the Texas Coastal Bend” Master’s Professional Paper (May 1987).

Permanent Address:

Department of Agricultural Economics
Texas A&M University
College Station, Texas 77843