AN ABSTRACT OF THE THESIS OF

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Title: A Demand System Analysis of Marketing Strategies for Apples and Pears in the Conventional Supermarket Environment

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This research examines how marketing strategies of produce managers affect consumer expenditures for fresh apples and pears. The objective of this study is to determine how display size, point-of-purchase material, product origin, product information and display placement impact consumer expenditures for fresh apples and pears. These variables were incorporated into a non-linear Almost Ideal Demand System with share equations for Gala, Fuji, Red Delicious, Other Sweet Apples, Tart Apples, and Pears. Forty-four weeks of data on weekly store sales were collected from two grocery stores in the Portland, Oregon metropolitan area. Share influences and elasticities are provided for price inputs and for other variables where appropriate. Product origin, e.g. state and national, influenced consumers' expenditures for Red Delicious apples and pears; it was insignificant in other share equations. Product information, e.g. tart or sweet, only influenced expenditures on apple varieties that are less familiar to the consumer. The size of point-of-purchase material had a significant effect on expenditures as did display sizes to a lesser extent. This research provided valuable information to produce managers and apple and pear producers on factors that influence consumers' expenditures at the retail level.

A Demand System Analysis of Marketing Strategies for Apples and Pears in the Conventional Supermarket Environment

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Marc V. McFetridge, Author

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1. INTRODUCTION

The produce department has become one of the most important departments that a grocery store has to offer. Produce sales have increased while sales in other sections of the grocery store, such as meat, dairy, and dry goods sections, have decreased (Perosio et al., 2001). Over the past decade, the per capita U. S. consumption of fresh fruits has increased by over seven percent (Schaffner, 2002). One explanation for this increase in fresh fruit consumptions is that consumers have become more health conscious. As a result, they are consuming more fresh fruits, namely apples, because they appear to reduce the risks of heart disease and different forms of cancers (Brooker et al., 1985, and Nayga, 1992).

Apples and pears are in plentiful supply for Pacific Northwest consumers and are important agricultural commodities for the region. An estimate for Oregon and Washington put production levels of apples at about 305,000 tons, which is approximately 53% of the total 2003 U.S. apple production. The estimated production level for pears produced in Oregon and Washington is approximately 655,000 ton, which is over 70% of total 2003 U.S. production of pears. With over fifty percent of the total U.S. production of both apples and pears being produced in Oregon and Washington, it is important to understand what factors affect Pacific Northwest consumer-purchasing habits at the retail level.

Apples and pears are also important to the total sales of the grocery store. Apple sales represent over 1% of the total grocery store sales. Overall apple sales are greater than coffee or toilet paper sales (Gentry, 2001). Pears may not be as important to total grocery store sales, but pears are substitutes for apples, and vice versa (Durham et al., 2002 and Voorthuizen et al., 2002). Therefore, to fully understand what factors impact retail sales of apples or pears, both fruit types need to be examined collectively. By examining how different marketing practices affect apple and pear sales, the effectiveness of those marketing practices can be determined. From this, influences can be drawn which will help with the produce department's and the store's overall profitability.

Produce managers are responsible for developing and implementing different marketing decisions for products within the produce department. These different marketing decisions include pricing, display sizes, point-of-purchase material, information on the characteristics of the product, information on where a product was produced, and the product itself. These various decisions can have direct impact on the sales of apples and pears, which affects the profitability of the produce department, and the grocery store as a whole. Examining how these marketing decisions affect the demand for fresh apples and pears will provide an insight into how those decisions are affecting sales of specific varieties of apples and pears.

1.1 Grocery Industry Overview

At the turn of last century consumers were forced to visit individual shops to meet their grocery needs. These specialty stores varied from bakeries to butchers. A typical shopping experience could result in visiting five or six specialty shops. Michael Cullen noticed time being wasted on each shopping trip and crafted a new idea. That idea was for a one stop shopping area that could meet all of the customer's grocery needs. In 1930 Michael Cullen opened a store based on his new idea. This store was located in a garage in the outskirts of New York City that gave consumers the ability to do all of their grocery shopping in one location. Michael Cullen's idea for the first U.S. grocery store has evolved over the years. This evolution has lead to the grocery store concept seen in Safeway, Wal-Mart superstores and many other major grocery store chains today.

Produce sales at supermarkets have surged to $36.96 billion over the last ten years. This is up forty-one percent from $25.96 billion. The produce department is becoming more important to the grocery store. The evidence for this is that produce sales as a percentage of total grocery store sales have doubled to an average of twelve percent over the last ten years (Berner, 1999). One reason for the increased sales in the produce department is the average number of products carried has increased. In 1987 an average store's produce department stocked 173 items and in 1997 it carried 335 items (Handy et. al., 2000). The variety of products offered has increased and will continue to increase. It is projected that by 2006 produce departments will carry, on average, over 400 different items (Perosio et. al., 2001 and Schaffner, 2002). With the produce department carrying so many different items, and its increasing importance to the grocery store's profitability, it has become vital to determine how different marketing practices affect the profitability of the produce department.

1.2 Objectives

The main purpose of this research is to determine how different practices by produce managers affect consumer purchasing behaviors of fresh apples and pears in a conventional grocery store environment. The following marketing practices used by produce managers will be examined to determine how affective they are in increasing sales of apples and pears:

- Display sizes
- Point-of-purchase signage
- Display placement
- Branding with the products' area of production
- Information on fruit characteristics
- In-store advertising

1.3 Overview

This thesis is broken into four additional chapters. A review of the literature is presented in Chapter 2, which contains a section focused on related economic factors and another on marketing strategies. Chapter 3 lays out the theoretical foundations for this thesis, the methodology, and the data used in the analysis. The regression results are discussed in Chapter 4 and conclusions and suggestions for future research are presented in Chapter 5.

2. LITERATURE REVIEW

Over the past three decades numerous studies have examined consumer-purchasing behavior for fresh apples and pears with respect to price, income, seasonality, and demographics. In this chapter articles are analyzed to determine what factors should be included in modeling the demand for fresh apples and pears. Section 2.1 will provide a background for the economic and consumer preference factors that affect consumer demand for fresh apples and pears. Section 2.2 will focus on articles examining marketing strategies for fresh apples and pears. Table 2.1 provides an overview of the articles that were reviewed for this study. The table provides the lead author, the type of data used in the study, the study's methodology, and the main topics relevant to this thesis. Table 2.1 shows that various methods and data used to look at the issue of demand for apples and pears, and that various factors have been considered. It is worth noting that no study considers all factors listed.

2.1 Economic and Consumer Preference Factors

The articles reviewed in this section provide the economic and consumer preference factors important in consumer purchase behavior for fresh apples and pears. This section is divided into four sub-sections: price, psychographics, demographics, and seasonality. Each of these sub-sections will relate the economic or consumer preference factors that were found to be relevant by previous studies in influencing consumer purchase behavior for fresh apples and pears.

Table 2.1 Articles Analyzed for Literature Review

Lead Author	Date	Data Source	Data Analysis Tool	Characteristics/ Factors Considered							
				Price	**Health/ Nutrition**	**Quality**	**Consumer Habits**	**Demographics**	**Promotion/ Advertising**	**Product Placement**	**Product Branding**
Ailawadi	1998	Scanner Data	Maximum Likelihood						X		
Allenby	1995	Scanner Data	Random Utility						X		
Beamer	1993	Survey	Summary Statistics							X	
Booker	1987	Survey	Summary Statistics		X						X
Brumfield	1993	Survey	Double Logged Demand Equation			X					X
Claxton	1979	Survey	Summary Statistics	X		X					
Cook	1990	Statement*	NA		X			X	X		X
Culverwell	1982	Statement	NA				X			X	
Duff	1989	Statement	NA		X						
Durham	2002	Scanner Data and Weekly Observations	LA/AIDS	X					X		X

Table 2.1 Articles Analyzed for Literature Review (cont.)

Lead Author	**Date**	**Data Source**	**Data Analysis Tool**	**Characteristics/ Factors Considered**							
				Price	**Health/ Nutrition**	**Quality**	**Consumer Habits**	**Demographics**	**Promotion/ Advertising**	**Product Placement**	**Product Branding**
Kujala	1993	Survey	Partial Least Squares	X			X				
Landry	1996	Statement	NA							X	
Lee	1989	Consumer Expenditure Survey	Entropy and Simpson Index		X						
Nayga	1995	Consumer Expenditure Survey	Heckit		X			X			
Nowlis	1996	Survey	Mean Squares Error			X					X
Owen	2002	Survey	Summary Statistics	X				X			
Perez	2001	Survey	Summary Statistics					X			
Perishables Group	2001	Survey	Summary Statistics	X		X	X				
Perosio	2001	Survey	Summary Statistics								X

Table 2.1 Articles Analyzed for Literature Review (cont.)

Lead Author	Date	Data Source	Data Analysis Tool	Characteristics/ Factors Considered							
				Price	**Health/ Nutrition**	**Quality**	**Consumer Habits**	**Demographics**	**Promotion/ Advertising**	**Product Placement**	**Product Branding**
Putnam	1999	USDA ERS and NASS Databases	Statistical Methods			X	X	X			
Quagrainie	2003	Scanner Data	Two-stage Maximum Likelihood								X
Raju	1992	Scanner Data	Multiplicative						X		
Richards	2000	AC Nielson HomeScan Panel Database	Maximum Likelihood and Least Squares	X				X	X		X
Vance Research Service	2003	Survey	Summary Statistics	X		X	X				
Voorthuizen	2002	Scanner Data	Two Staged Least Squares	X					X		

* statements are based on expert opinions

2.1.1 Price and Price Elasticities

Numerous researchers have examined how price affects demand. Articles over the last thirty years have noted the effects price has on consumers purchasing behavior for fresh apples. The organization of this section is by articles based on demand studies followed by survey-based articles.

Richards (2000) looked at the demand for apples using an ordinary least squares model to analyze panel data from July through December 1997. Richards found that the average reservation price - the maximum price a buyer is willing to pay for one unit of a good rather then doing without it; of $0.99 was significant for all the apple varieties in this study. While prices were significant, the demand for apples was found to be price-inelastic. So, changes in own-price will have relatively little affect on the demand for apples. Table 2.2 presents the elasticity results from the article by Richards.

Table 2.2 Elasticities from Richards (2000)

	Red Delicious	Golden Delicious	Granny Smith	Specialty Apples*
Own-Price Elasticities	-0.147	-0.288	-0.335	-0.188

* Specialty Apples: Fuji, Gala, Braeburn etc.

An article by Durham et al. (2002) determined, by using an LA/AIDS model for a seemingly unrelated system of share equations, that own-prices are significant and negatively influence the demand for fresh apples. With thirty-four weekly observations and scanner data from four stores of a major grocery store chain in Portland, Oregon and surrounding areas, the results on cross-prices revealed weak substitutability between certain apple varieties. Gala apples were found to be weak substitutes for Fuji and Red Delicious apples, and Fuji apples were found to be weak substitutes for Gala apples. Table 2.3 displays the price coefficients and the corresponding t-values for each share equation from the article by Durham et al. (2002). Quantity demanded for apples is inelastic with respect to cross-price

Table 2.3 Price Coefficients and t-values from Durham et al. (2002)*

Demand Equations**	Gala Price	Fuji Price	Red Delicious Price
Gala	-0.1434[a] (-5.24)	0.0504[b] (1.84)	-0.0239 (-0.61)
Fuji	0.080[b] (1.97)	-0.054 (-1.27)	0.095[c] (1.52)
Red Delicious	0.0797[a] (3.91)	0.0121 (0.57)	-0.0413[c] (-1.32)

* t-values are in parenthesis

** [a] signifies variables that are significant at a 1% level, [b] signifies variables that are significant at a 5% level, [c] signifies variables that are significant at a 10% level

elasticities, but quantity demanded is price-elastic with respect to own-price for Gala and Red Delicious apples. Table 2.4 provides the own-price and cross price elasticities from the article by Durham et al. (2002).

Table 2.4 Own and Cross-Price Elasticities from Durham et al. (2002)

Demand Equations*	Gala Price	Fuji Price	Red Delicious Price
Gala	**-2.35**	0.47	0.64
Fuji	0.62	**-0.98**	0.16
Red Delicious	-0.14	0.52	**-1.21**

* Own-price elasticities are bolded

The two different demand studies both found own-prices to be important in influencing consumer purchase habits for fresh apples. The own-price elasticities are negative in both studies. However, in the article by Richards the own-price elasticities are inelastic and in Durham et al. the own-price elasticities are elastic for Gala and Red Delicious apples. No information was provided in the Richards article about substitutability between fresh apple varieties, but Durham et al. found weak substitutability between certain apple varieties.

Adding to the findings from Durham et al. the substitutability between fresh apple varieties, Voorthuizen et al. (2002) found that substitutes for fresh apple varieties are other fresh apple and pear varieties. Voorthuizen et al. examined the monthly domestic demand and supply for Washington apples by using aggregated monthly scanner data from September 1990 through August 2000. The aggregated monthly scanner data was analyzed using a two staged least squares model.

Another article on the topic of apple substitutes found that organic apples are not substitutes for regular apples. Loureiro et al. (2001) used a multinomial logit model to analyze 285 surveys conducted in January 2000. The surveys and analysis was designed to examine consumers' preferences for organic, eco-labeled and regular apples. Based on the finding from Loureiro et al. no organic products were included in this thesis.

The articles based on surveys found similar results as compared to the demand studies for fresh apples that price is an important factor-influencing consumer purchasing behaviors. A survey by Claxton and Ritchie (1979) found that price is the number one factor influencing consumer purchase behavior for fresh produce. Claxton and Ritchie surveyed 128 women, from five major urban centers in Canada, and found that high prices were the number one concern about fresh produce.

Surveys by Kujala and Johnson (1987), Own et al. (2001), Perishables Group (2001), and Vance Research Services (2003) found that while prices are important, other factors also influence consumers' fresh fruit purchase behavior. The surveys conducted by Kujala and Johnson was collected on Finnish consumers' purchases of fresh foodstuffs. Kujala and Johnson demonstrated that consumers use cross-price information as well as own-price information in their purchasing decisions for fresh fruit, when that information is readily available. Kujala and Johnson concluded that consumer demand for habitual, low involvement products, like produce, should be relatively price inelastic on any given purchase occasion. Own et al. surveyed twenty-four Australian shoppers on their normal shopping patterns. The survey concluded that only 45.7% of the shoppers noted a price reference. Over 50% of the time shoppers were referencing other factors besides price in the decision making process for fruit. Perishables Group surveyed over 1200 consumers and found that appearance was the most important factor persuading people to buy fruit, followed by price. Vance Research Service surveyed one thousand households representing the

U.S. population. They found fresh produce that is appetizing in appearance is the number one factor persuading consumers to buy fresh fruit followed by price.

The demand studies and the studies based on surveys show that price is an important factor in determining consumer purchase behaviors for fresh fruit, but other factors need to be taken into account. Besides own-price, cross-prices need to be included on substitutes for fresh apple varieties. The substitutes that have been found for fresh apple varieties are other fresh apple and fresh pear varieties. While prices are important to consumers, they are being influenced by non-price factors in their purchasing behaviors as well.

2.1.2 Psychographics

Psychographics are other non-price factors, based on consumers' tastes and preferences that can influence consumer-purchasing behaviors for fresh apples or pears. In this section the psychographics that will be covered include nutrition/health, quality, and consumer behavior, as reported by survey-based articles. It is expected that each of these psychographics can influence consumers' purchasing habits for fresh apples and pears.

2.1.2.1 Nutrition/Health

Surveys based studies demonstrate that consumers are implementing a more diverse diet by increasing their consumption of fresh fruits and vegetables for a healthier lifestyle. Nayga (1995) conducted surveys and found that the consumption of fresh fruits has been stimulated by an apparent increase in consumer interest in food nutrition and personal health. Nayga did this by analyzing data from the 1992 Consumer Expenditure Survey from the Bureau of Labor Statistics.

Lee and Brown (1989) examined the demand for food diversity based on data from the 1981 Consumer Expenditure Survey conducted by the Bureau of Labor Statistics. Findings from the surveys indicated that females older than twenty-six found diversity to be an important component of their diet.

According to Cook (1990), there has been a sizeable increase in general knowledge about how diet and health are linked. Consumers need to know what products are considered healthy and nutritious so they can implement these products into their diets. Therefore, the use of nutritional facts can be important factors in determining consumers' purchase behavior.

2.1.2.2 Quality

The appearance of fresh fruit at the retail level, or quality can influence consumers' purchase behaviors. Surveys conducted by Perishables Group (2001) and Vance Research Service (2003) revealed that appearance influences fresh fruit purchases. The Perishables Group conducted over 1200 in-store consumer interviews and concluded that appearance is the most important factor influencing unplanned fresh fruit purchases. The Vance Research Service surveyed one thousand U.S. households concluded that fresh fruit that looked appetizing is the number one persuading factor in determining consumer purchase decisions for fresh fruit. Fresh fruit that consumers view as appetizing or that looks good on display are viewed as high quality fresh fruits. A similar result was observed from surveys conducted by Claxton and Ritchie (1979). Their study revealed that poor-quality is the second most observed complaint by consumers about fresh produce.

A bulletin on historical data on food consumption, prices, expenditures, income, and population in the U.S., by Putnam and Allshouse's (1999) notes that better quality has increased consumption of fresh fruits and vegetables. Their findings are based on the analysis of data gathered from the ERS trade association databases and from the National Agricultural Statistics Service (NASS) of the USDA.

Brumfield et al. (1993) surveyed 423 consumers in four different New Jersey supermarkets to gain insight into consumers' tastes and preferences, quantities purchased and prices paid for fresh tomatoes. A double logged demand equation was used to analyze the surveys. According to the results overall quality is a significant factor in determining the demand for tomatoes. Brumfield et al. found that consumers are willing to pay a higher price for tomatoes that have a good appearance, and lack blemishes.

The appearance, or quality of fresh fruit at the retail level has become an important factor in determining consumer-purchasing behavior for fresh fruit. Consumers view high quality fresh fruit as appetizing, because it has a good appearance, and lacks blemishes.

2.1.2.3 Consumer Behavior

Consumer's actions for planned purchases are different than their actions for impulse purchases. Perishable Groups (2001) indicated that buying certain varieties of fresh fruit are planned purchases. Most consumers plan to purchase apples, while pears are mainly purchased on impulse. According to Culverwell and Eder (1982), planned purchases are those items that consumers plan to purchase before entering the grocery store, while impulse purchases are items that might catch the consumer's eye while collecting the planned items. Vance Research Service (2003) concludes that as income levels increase the purchase of fresh fruits become more based on impulse.

2.1.3 Demographics

Income levels are one of the demographic factors that can influence consumer-purchasing behaviors. As a result, income has been incorporated into the work of Own et al. (2002), Perez et al. (2001), Richards (2000), and Cook (1990). In the results of Richards and Perez et al., as income increases consumers become more likely to select fresh apples over other alternatives. Cook and Own et al. also note that as income levels increase consumers place on more value on fruit quality then price.

Another demographic topic that is important in determining purchasing behavior for fresh apples is consumer age. Nayga (1995) and Cook (1990) found that as the age of the primary shopper increases their expenditures on fresh fruit increases.

Household size may also play an important role in a consumer's purchasing decisions. According to Richards (2000) and Nayga (1995), as household size increases the expected expenditures on fresh fruit increased. Contrary to the findings of Richards and Nayga, Cook (1990) and Lee et al. (1989) found that as household size increases the expenditures on fresh fruit decrease.

Perez et al. (2001) and Nayga (1995) discuss topics that were not found in other articles. These topics are race, education level, location in the U.S. and gender. According to Nayga, families headed by a Caucasian are more likely to purchase fresh fruit. Individuals with a college degree generally spend more on fresh fruit than individuals with a high school or lower education level. Perez et al. adds that apple consumption is favored in the Western United States and that males have a stronger preference for apples than females.

The topics on demographics that have been covered in this section are important in determining purchasing behaviors for fresh fruit. However, to address these issues data on individual consumers must be collected. Since that information is unavailable, the demographic factors are not included in this thesis.

2.1.4 Seasonality

Consumers' shopping patterns change from one time of the year to the next. Nayga (1995) finds that weekly household expenditures on fresh fruit are higher in the second and third quarters than in the fourth quarter of the year.

Beamer and Preston (1993) examined the organization of fresh produce marketing with retail supermarket chains. The results of the surveys indicate that some fresh apple and pear varieties may not be found in the produce department year round due to seasonal availability. For example, in the fresh apple industry more varieties will be imported in the spring and early summer months. Thus, seasonal availability of apple and pear varieties will have an impact on demand.

The economic and consumer preference factors section analyzed demand articles and survey results to identify what factors are important in influencing consumers' purchase behavior for fresh apples and pears. Of these factors, those that will be included in the model for the demand for fresh apples and pears are own-price, price of substitutes, information on the nutrition and health, product quality, items that effect consumer purchase habits, and seasonality. No demographic factors will be included, because no information on those factors was available.

2.2 Marketing Strategies

Marketing strategies are designed to increase demand for a given good or service. The marketing strategies that have been found, by previous studies, to influence the demand for apples and pears are: promotions/advertising, product placement, and product branding.

The reason to promote or advertise a product is to persuade consumers to purchase a product that they would normally not. Promotions and advertising can take the form of price specials, increase the available information about the product, or a combination of the two. Ailawadi and Neslin (1998) and Raju (1992) found that the use of promotions increased sales of the promoted products. Using a maximum likelihood model to analyze 102 weeks of scanner data from two U.S. markets, Ailawadi and Neslin found that when perishable items are promoted the consumption rate increases. Using a multiplicative model to analyze a 25-week period of scanner data collected from one store of a national grocery chain, Raju concluded that those product categories that were placed on a price discount would see an increased level of sales that reflected the magnitude of the discount. It is interesting to note that promotions are less effective for those products that are bulky or that have a number of competitors.

Allenby and Ginter (1995) analyzed 225 observations of scanner data from four grocery chains in Springfield, Missouri and found that advertising exhibits a significant and positive influence on the probability of choice. This effect is particularly strong for products that were featured in the store's fliers, suggesting that the use of feature advertising is more effective than in-store display advertising. The study indicates that in-store displays and feature advertisements serve to increase the demand of a specific product and reduce the influence of price in the purchase decision.

Richards (2000), Durham et al. (2002) and Voorthuizen et al. (2002) found that promotions and advertising are both important in the demand for fresh apples. Richards used an ordinary least squares model to analyze panel data. He found that the most important variables influencing consumer purchase behaviors of fresh fruit are promotion and advertising. Similarly Durham et al. found that price promotions were important in increasing the demand for Gala and Red Delicious apples. Voorthuizen used a two-staged least squares model to analyze ten years of data from retail stores throughout the U.S. found that price promotions are significant factors that positively impact apple sales.

The location within a store that a product is displayed or product placement has also been found to be influential on sales. Landary (1996), Allenby et al. (1995) and Culverwell et al. (1982) looked at how product placement affects consumers' purchasing habits. According to Landery when products were displayed on their own, for example an end aisle display, consumers tend to buy on impulse, be influenced by advertisement exposure and overall experience from the product. When products are displayed together consumers give extra weight to easily observable attributes such as unique features and information provided in the point-of-purchase material. Allenby et al. found that display placement influences on the probability of choice. Similar to Allenby et al.'s findings Culverwell states that items placed in active zones should see an increase in sales. Active zones included areas where people accumulate such as, aisle ends, aisle junctions, and aisle crossings. Non-active sales zones are corners and middle gangways. Different product placements will lead to different probabilities of consumers observing the product. Those product placements that heighten the probability of being noticed should increase sales.

Product branding has become an important way to differentiate similar products. Incorporating different labels to provide consumers information on where apples and pears varieties are produced. Brumfield et al. (1993) and Brooker et al.

(1987) found that consumers place a higher quality value on tomatoes that were locally grown. Brumfield et al., analyzed 423 surveys from four different New Jersey supermarkets, and found that consumers are willing to pay higher prices for locally grown tomatoes. The price elasticities for the branded locally grown tomatoes were inelastic while those tomatoes that did not have a locally grown brand were elastic. Brooker et al. surveyed 231 households in Knox County, Tennessee and found that over fifty percent of the respondents would be willing to purchase locally grown tomatoes at a slightly higher price than out-of-state tomatoes. The result from the willingness to buy articles provides a starting point to determine how different labels affect consumers' purchasing habits. It is important to treat information gathered from these articles carefully because consumers do not always act according to their stated level of willingness to pay.

Nowlis and Simonson (1996) investigated factors influencing brand choice when new accessories are added to an existing product. Surveys of visitors to a science museum and undergraduate marketing students were analyzed using the mean squares error from the overall analysis of the variance table. Nowlis and Simonson found that relatively inferior products, like produce, gain more from the introduction of a new accessory, or brand that informs consumers on production location.

Perosio et al. (2001) studied the challenges and changes within the fresh produce distribution system. A questionnaire was sent out to 270 produce retailers in 2001 with 44 useable questionnaires returned. Respondents to the questionnaire ranged from single store operators to the largest of the multi-million dollar retail operators. Following the lead of other privately branded products in supermarkets such as household products, soft drinks, and health and beauty aids, fresh produce may also benefit from a private brand.

Cook (1990) comments on the changing fresh fruit industry structure that has stimulated the introduction of brands of fresh produce. Changes in technology have lead to the possibility of a year-round product at a consistently high quality level. Consumption of canned fruits and vegetables has declined, opening the market for fresh produce brands. Changes in the fresh fruit industry have lead to the possibility of consumers' referencing high quality fresh fruit in recognition of specific brands. Quagrainie et al. (2003) found similar results relating to the branding of Washington apples. Using a two-stage maximum likelihood model to analyze four years of scanner data from a number of major U.S. cities, they found that there is a possible existence of reputation for Washington apples.

2.3 Summary

From the different articles examined for this thesis the demand for fresh apples and pears takes into account a variety of different economic, consumer preference, and marketing factors that can influence consumers' purchasing behavior. The demand articles illustrate the economic factors that are important in modeling the demand for fresh apples are own-price, price of other fresh apple varieties, and the price of fresh pear varieties. The articles based on consumer preferences outline the factors such as information on nutrition/health, product quality, consumer behavior, and seasonality. The marketing factors found to be important in modeling the demand for fresh apples and pears by pervious studies are factors that increase impulse purchases, promotions, advertising, product placement, and product branding. All of these factors need to be considered when modeling the demand for fresh apples and pears in order to determine how apple and pear sales are affected by different marketing strategies that produce managers use at the retail level.

3. METHODOLOGY and DATA

This chapter provides a framework for the regression model chosen for the study and a description of the data. The following sections will provide a clear understanding of the methodology used to analyze demand and the data utilized to determine how different marketing strategies affect the demand for fresh apples and pears.

3.1 Method

This method section covers the fundamental properties of demand, the derivation of demand equations, and the derivation of the functional form chosen for this study. These sections will cover the demand and functional form used in this thesis.

3.1.1 Demand

The basic premise of consumer demand is that consumers maximize their utility subject to various budget constraints. Before discussing the concept of utility or constraints, a set of properties that are used to characterize rational behavior are presented.

Consumers are assumed to exhibit preferences that have four basic properties: reflexivity, completeness, transitivity, and continuity.[1]

Reflexivity - Preferences can be placed on any bundle of goods, i.e. bundle A is preferred to bundle B.

Completeness - If A and B are different bundles, then the consumer can specify three possibilities:
1). A is preferred to B
2). B is preferred to A
3). The consumer is indifferent between either A or B

Transitivity - If an individual makes the statement that "A is preferred to B" and the statement that "B is preferred to C" then the statement "A is preferred to C" must also hold.

Continuity - If a consumer has a choice between A and B and "A is preferred to B" then choices suitably close to A will be preferred to B.

These four properties, taken together, indicate that it is possible for people to rank, in order, all possible bundles from the least preferred to the most. A bundle refers to the specific quantity of goods or services that might be chosen by the consumer at any given time. The bundles that are more preferred will offer consumers a greater degree of satisfaction.

Utility is the theoretical quantitative representation of the degree of satisfaction that is obtained from the consumption of a bundle of goods. The higher the utility the greater the benefit a consumer gains from consuming a given bundle. The utility for any given bundle of goods can be represented by a utility function:

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[1] The information on utility was referenced from the book *Microeconomic Theory* by Walter Nicholson (2002)

$$U = v(x_1, x_2, \ldots, x_n) \qquad \text{Eq. 3.1}$$

where v is the functional form of utility and x_i are the quantities of each good consumed.

The nonsatiation axiom states how consumers desire bundles of goods.

> Nonsatiation: A consumer always prefers a consumption bundle with more of both goods to a bundle with less. Given any two consumption bundles A and B, if bundle A contains more of one good than bundle B, and if it does not contain less of the other good, then bundle A is preferred to bundle B.

The underlying meaning of this axiom is that consumers always desire a higher level of utility and thus consumers desire more goods to less. Without constraints consumers will continually select bundles of goods, which provide the highest level of utility. The selection process will be never ending due to the fact that levels of utility theoretically increase to infinity.

Due to the fact that most goods are not free, consumers' levels of utility are constrained by the amount of money they have or their budget. The budget constraint takes the mathematical form:

$$\sum_{i=1}^{n} p_i x_i = I \qquad \text{Eq. 3.2}$$

where n is the total number of goods, p_i is the positive price for good i, and x_i is the non-negative quantity purchased of good i. I is the total income for an individual consumer. The goal of individual consumers is to choose the amount of every x_i that maximizes their level of utility subject to their budget constraint. The mathematical representation of the utility maximizing process given the budget constraint is:

Maximize $U = v(x_1, x_2, \ldots, x_n)$,

Subject to $\sum_{i=1}^{n} p_i x_i = I$ Eq. 3.3

The solution to this problem yields the levels of x_i, which generate the highest level of utility. It is possible to reformulate the problem as a cost minimization problem. This is the process of selecting the optimal level of goods that minimize the costs necessary to achieve the same level of utility as would be found by the utility maximization process.[2]

The process of cost minimization is represented mathematically as:

Minimize: $\sum_{i=1}^{n} p_i x_i = E$

Subject to $v(x_1, x_2, \ldots x_n)$ Eq. 3.4

where E is total expenditures. Given the property of nonsatiation, a rational consumer will spend all of their income, and $E = I$ from equation 3.3 because

[2] The information on the dual problem is from *Economics and Consumer Behavior* by Deaton and Muellbauer (1980)

$\sum_{i=1}^{n} p_i x_i = \sum_{i=1}^{n} p_i x_i$. Since $E = I$, then the solutions to the utility maximization and cost minimization processes yield the same optimal levels of x_i.

There are five properties of the cost function that will provide valuable information into the cost minimization process. These five properties are:

Property 1: The cost function is homogeneous of degree one in prices, i.e. if all prices double then it will take twice the income to maintain the same level of utility.

Property 2: The cost function is increasing in U, nondecreasing in p and increasing in at least one price, i.e. at a given price level the consumer has to spend more to be better off.

Property 3: The cost function is concave in prices, i.e. as prices rise, costs rise no more then linearly.

Property 4: The first and second derivatives of the cost function with respect to price exist everywhere except at a possible set of price vectors that have a measure of zero.

Property 5: The partial derivatives, where they exist, of the cost function with respect to prices are the Hicksian demand functions. That is:

$$\frac{\partial e(u,p)}{\partial p_i} = h_i(u,p) = x_i \qquad \text{Eq. 3.5}$$

Once a cost function has been defined, demand functions can be derived. From Property 5, demand functions for x_i are equal to the partial derivative of the cost functions with respect to p_i, or the Hicksian demand function.

From the five properties of a cost function, four conditions are derived and must be met for any cost function.

Condition 1: Homogeneity. A demand equation that is homogeneous of degree zero exhibits the property that if all prices and income can be multiplied by the same factor the optimal quantities demanded would remain unchanged. The previous sentence can be quantitatively represented as:

$$x_i = \psi_i(p, I) = \psi_i(tp, tI) \qquad \text{Eq. 3.6}$$

Condition 2: Negativity. The n-by-n matrix formed by the elements $\partial h_i / \partial p_j$ is negative semi-definite, which means that an increase in price with utility held constant must cause demand for that good to fall or at least remain unchanged.

Condition 3: Adding-up. The sum of the estimated expenditures of the demand system on different goods must equal the total expenditures in any one period ($\sum_{i=1}^{N} p_i x_i = I$). Differentiating the budget constraint with respect to income will yield the following expression:

$$\sum_{i=1}^{N} \frac{\partial(\sum_{i=1}^{n} p_i x_i)}{\partial I} = 1 \qquad \text{Eq. 3.7}$$

Condition 4: Symmetry. The symmetry condition guarantees that individual consumer's preferences are consistent. For example the preferences of bread for milk will be the same as milk for bread. To check to see if the symmetry condition holds, the cross price elasticities between the same goods should be equal in the Slutsky or substitution matrix.

This theoretical demand section provides useful information on how demand equations are developed. The development process is a mathematical process that begins with the properties for rational consumers and ends with specific demand equation conditions.

3.1.2 Functional Form

The sections on functional form will provide an insight into the selection of the model chosen to estimate the demand of specific apple and pear varieties. Once the foundation has been provided, the theoretical fundamentals behind the model will be specified.

3.1.2.1 Selection of the Econometric Model

The demand for specific apple and pear varieties within a specific store are expected to have correlated error terms. This is expected because the quantity of various fresh fruit varieties sold indirectly affects quantities sold of other fresh fruit varieties. The seemingly unrelated regression model allows separate, but related, equations to take into account the likely relationship between equation error terms. The Almost Ideal Demand System was selected to model the seemingly unrelated regression of quantity demanded of specific apple and pear varieties.

3.1.2.2 Almost Ideal Demand System

The Almost Ideal Demand System is often used to model consumer demand principally because it conforms to expectations about demand and allows for the testing of the assumptions of symmetry and homogeneity. Angus Deaton and John Muellbauer developed the Almost Ideal Demand System (AIDS) in 1980, to overcome some of the problems of the Rotterdam and translog models.[3] The AIDS model is relatively easy to estimate and to test for symmetry and homogeneity.

The Almost Ideal Demand System (AIDS) is derived from a specific class of preferences, which by the theorems of Muellbauer (1975) permit exact aggregation over consumers. These preferences, known as the PIGLOG class, are derived from the expenditure function. The expenditure or cost function will be denoted in the functional form $e(U,p)$ for a given level of utility U and p is the vector of prices. The PIGLOG class is defined by:

$$\log e(U,p) = (1-u)\log\{a(p)\} + u\log\{b(p)\} \qquad \text{Eq. 3.8}$$

where U lies between 0 (subsistence) and 1 (bliss).

Specification for the AIDS model must result in the cost function taking a flexible functional form. In order for a cost function to take a flexible functional form, the cost function must possess enough parameters so that at any single point the

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3 The information referenced in this section follows the article *An Almost Ideal Demand System* by Deaton and Muellbauer (1980)

derivatives $\partial e/\partial p_i$, $\partial e/\partial U$, $\partial^2 e/\partial U \partial p_i$, $\partial^2 e/\partial p_i \partial p_j$, $\partial^2 e/\partial U \partial p_i$, and $\partial^2 e/\partial U^2$ can be set equal to an arbitrary cost function. Log *a(p)* and log *b(p)* are arbitrary cost functions defined mathematically as:

$$\log a(p) = a_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log p_k \log p_j \qquad \text{Eq. 3.9}$$

and

$$\log\ b(p) = \log\ a(p) + \beta_0 \prod_k p_k^{\beta_k} \qquad \text{Eq. 3.10}$$

The mathematical representation of log *a(p)* and log *b(p)* is governed partly by the need for a flexible functional form and that these functions lead to a system of demand functions that are easy to tests for the demand conditions of homogeneity and symmetry. The AIDS cost function can be rewritten:

$$\begin{aligned} \log e(U,p) = a_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log p_k \log p_j \\ + u\beta_0 \prod_k p_k^{\beta_k} \end{aligned} \qquad \text{Eq. 3.11}$$

where α_k, β_i and γ_{kj}^* are the parameters of the AIDS cost function.

In section 3.1 demand functions were found from the partial derivative of a cost function. By taking the first partial derivative of the AIDS cost function, equation 3.11, with respect to prices will provide the quantities demanded:

$$\partial \log e(U,p)/\partial \log p_i = x_i \qquad \text{Eq. 3.12}$$

Multiplying both sides of the equation by $p_i/e(U,p)$ will yield the following equation:

$$\frac{\partial \log e(U,p)}{\partial \log p_i} = \frac{p_i x_i}{e(U,p)} = w_i \qquad \text{Eq. 3.13}$$

where w_i is the budget share of good *i*. The logarithmic differentiation of equation 3.11 gives the budget shares as a function of utility and prices:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i u \beta_0 \prod p_k^{\beta_k} \qquad \text{Eq. 3.14}$$

where

$$\gamma_{ij} = \frac{1}{2}(\gamma_{ij}^{*} + \gamma_{ji}^{*}) \qquad \text{Eq. 3.15}$$

For a utility-maximizing consumer, the total expenditure E is equal to *e(U,p)*. Inverting this equality will provide U as a function of p and E, the indirect utility function. Inverting equation 3.11 and substituting the result into equation 3.14 will yield the budget shares as a function of p and E:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_i + \beta_i \log\{E/P\} \qquad \text{Eq. 3.16}$$

where log P is a price index that is defined by:

$$\log P = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2}\sum_j \sum_k \gamma_{kj} \log p_k \log p_j \qquad \text{Eq. 3.17}$$

These transformations provide the AIDS demand functions in the budget share form.

The demand conditions for the AIDS model, equation 3.16, can be imposed by the following restrictions in Table 3.1. The table is broken down by the demand conditions and the corresponding imposable restrictions.

Table 3.1 AIDS Model Imposable Restrictions

Demand Conditions	Imposable Restrictions
Adding-up	$\sum_i \alpha_i = 1$, $\sum_i \gamma_{ij} = 0$, $\sum_i \beta_i = 0$
Homogeneity	$\sum_j \gamma_{ij} = 0$
Symmetry	$\gamma_{ij} = \gamma_{ji}$

The sets of restrictions provide a way to insure that the AIDS model, equation 3.16, meets the demand conditions of adding-up, homogeneity of degree zero and symmetry.

The AIDS model also satisfies the axioms of preference: reflexivity, completeness, transitivity, and continuity. The model is relatively simple to estimate, and can be tested to see if the restrictions of homogeneity and symmetry are held.

3.1.2.2.1 Test of the AIDS Model

Tests of the AIDS model determine whether the demand conditions of adding-up, homogeneity of degree zero, and symmetry based upon the restrictions listed above, are meet. A Wald test is used to test the restrictions of adding-up, homogeneity of degree zero, and symmetry. The calculated Wald test statistic is compared to a χ^2 critical value significant at a one percent level for the number of restrictions. The Wald test statistic is calculated using the following formula:

$$\lambda_W = \frac{SSE_R - SSE_U}{\hat{\sigma}^2} \qquad \text{Eq. 3.18}$$

where SSE_R is the sum of squared errors in model when the restrictions are imposed, SSE_U is the sum of squared errors in the model when the restrictions are not imposed, and $\hat{\sigma}^2 = SSE_U/(T-K)$. T is the number of observations from the data set and K is the number of independent variables in the model. If the calculated Wald statistic is greater than the χ^2 critical value then the null hypothesis, that there is no statistical difference between the restricted and non-restricted model, is rejected. If the Wald statistic is less then the χ^2 critical value, then there is a failure to reject the null hypothesis.

To test if autocorrelation in errors is present, a Durbin-Watson statistic is calculated and compared to upper and lower bound critical values. The Durbin-Watson statistic is expressed as:

$$d = \frac{\sum_{t=2}^{T} (\hat{e}_t - \hat{e}_{t-1})^2}{\sum_{t=1}^{T} \hat{e}_t^2} \qquad \text{Eq. 3.19}$$

where $\hat{e}_t$ is the least squares residuals from the regression at observation t, and T is the total number of observations. The upper and lower bound critical values for the Durbin-Watson test are presented in a Durbin-Watson table according to significance level and the number of observations. If the Durbin-Watson statistic is less than the lower bound then it indicates that autocorrelation is present. If the Durbin-Watson statistic is greater than the upper bound then it indicates that autocorrelation is not present. If the Durbin-Watson statistic is between the upper and lower bounds then the statistic is inconclusive in determining if autocorrelation is present.

3.1.2.2.2 Elasticities for the AIDS Model

Price elasticity is defined as the percentage change in quantity demanded for some good with respect to a one percent change in the price of the good (own price elasticity) or of another good (cross price elasticity). The mathematical formula for own and cross-price elasticity is:

$$\varepsilon_{ij} = \frac{\%\Delta q_i}{\%\Delta p_i} = \frac{\Delta q_i / q_i}{\Delta p_i / p_i} = \frac{\Delta q_i}{\Delta p_i} * \frac{p_i}{q_i} \qquad \text{Eq. 3.20}$$

where ε_{ij} is the cross price elasticity when $i \neq j$, or own price elasticity when $i = j$, p_i is the price on the i^{th} good, and q_i is the quantity demanded for the i^{th} good. An elasticity greater than one is called elastic, and an elasticity smaller than one is called inelastic. If an elasticity is close to one then it is referred to as being unit elastic. A given percentage increase in the price of an elastic good will reduce the quantity demanded for the good by a higher percentage than for an inelastic good.

Expenditure elasticity is defined as the percentage change in quantity demanded with respect to a one percent change in expenditures. The mathematical formula for expenditure elasticity is:

$$\varepsilon_E = \frac{\%\Delta q_i}{\%\Delta E} = \frac{\Delta q_i / q_i}{\Delta E / E} = \frac{\Delta q_i}{\Delta E} * \frac{E}{q_i} \qquad \text{Eq. 3.21}$$

where E is total expenditure.

Total display size elasticity is defined as the percentage change in quantity demanded with respect to a one percent change in total display size. The mathematical formula for total display size elasticity is:

$$\varepsilon_{TD} = \frac{\%\Delta q_i}{\%\Delta TD} = \frac{\Delta q_i / q_i}{\Delta TD / TD} = \frac{\Delta q_i}{\Delta TD} * \frac{TD}{q_i} \qquad \text{Eq. 3.22}$$

where *TD* is total display size.

Total point-of-purchase material elasticity is defined as the percentage change in quantity demanded with respect to a one percent change in the total point-of-purchase material. The mathematical formula for total point-of-purchase material elasticity is:

$$\varepsilon_{POP} = \frac{\%\Delta q_i}{\%\Delta POP} = \frac{\Delta q_i / q_i}{\Delta POP / POP} = \frac{\Delta q_i}{\Delta POP} * \frac{POP}{q_i} \qquad \text{Eq. 3.23}$$

where *POP* is total point-of-purchase signage.

The parameters from the AIDS model are not elasticities but can be derived through mathematical manipulation of the parameters. To find the own-price elasticities take equation 3.16 and partially differentiate both sides of the equations with respect to $\ln p_i$.

$$\frac{\partial w_i}{\partial \ln p_i} = \gamma_{ii} - \beta_i w_i \qquad \text{Eq. 3.24}$$

Substituting $p_i q_i / E$ in for w_i reveals

$$\frac{\partial w_i}{\partial \ln p_i} = \frac{\partial\left(\frac{p_i q_i}{E}\right)}{\frac{\partial p_i}{p_i}} = \frac{p_i}{E} * \frac{\partial (p_i q_i)}{\partial p_i} = \frac{p_i}{E}\left(q_i + p_i * \frac{\partial q_i}{\partial p_i}\right) = \frac{p_i q_i}{E} + \frac{p_i^2}{E} * \frac{\partial q_i}{\partial p_i} \qquad \text{Eq. 3.25}$$

Substituting w_i in for $p_i q_i / E$ reveals

$$\frac{p_i q_i}{E} + \frac{p_i^2}{E} * \frac{\partial q_i}{\partial p_i} = w_i + \frac{p_i^2}{E} * \frac{\partial q_i}{\partial p_i} \qquad \text{Eq. 3.26}$$

Set $w_i + \frac{p_i^2}{E} * \frac{\partial q_i}{\partial p_i}$ equal to $\gamma_{ii} - \beta_i w_i$ because $\frac{\partial w_i}{\partial \ln p_i} = \frac{\partial w_i}{\partial \ln p_i}$.

$$\gamma_{ii} - \beta_i w_i = w_i + \frac{p_i^2}{E} * \frac{\partial q_i}{\partial p_i} \qquad \text{Eq. 3.27}$$

Moving w_i and $\frac{p_i^2}{E}$ to the left hand side of the equations leaves

$$(\gamma_{ii} - \beta_i w_i - w_i)\frac{E}{p_i^2} = \frac{\partial q_i}{\partial p_i} \qquad \text{Eq. 3.28}$$

To find the own-price elasticity $\frac{\partial q_i}{\partial p_i}$ needs to be multiplied by $\frac{p_i}{q_i}$

$$\frac{\partial q_i}{\partial p_i} * \frac{p_i}{q_i} = (\gamma_{ii} - \beta_i w_i - w_i)\frac{E}{p_i^2} * \frac{p_i}{q_i} = (\gamma_{ii} - \beta_i w_i - w_i)\frac{E}{p_i q_i} \qquad \text{Eq. 3.29}$$

Substituting $\frac{1}{w_i}$ in for $\frac{E}{p_i q_i}$ reveals

$$\frac{\partial q_i}{\partial p_i} * \frac{p_i}{q_i} = (\gamma_{ii} - \beta_i w_i - w_i)\frac{1}{w_i} = \frac{\gamma_{ii} - (\beta_i + 1)w_i}{w_i} = \frac{\gamma_{ii}}{w_i} - \beta_i - 1 \qquad \text{Eq. 3.30}$$

So the own-price elasticities for the AIDS model are

$$\frac{\partial q_i}{\partial p_i} * \frac{p_i}{q_i} = \frac{\gamma_{ii}}{w_i} - \beta_i - 1 \qquad \text{Eq. 3.31}$$

To calculate the cross-price, expenditure, total display size and total point-of-purchase material similar mathematical manipulations of the parameters will provide the elasticities. The cross-price elasticity is:

$$\frac{\partial q_i}{\partial p_j} * \frac{p_j}{q_i} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} \qquad \text{Eq. 3.32}$$

The expenditure elasticity is:

$$\frac{\partial q_i}{\partial E} * \frac{E}{q_i} = \frac{\beta_i}{w_i} + 1 \qquad \text{Eq. 3.33}$$

The total display size elasticity is:

$$\frac{\partial q_i}{\partial TD_i} * \frac{TD_i}{q_i} = \frac{TD_i(1 - \gamma_{ii} \ln p_i)\delta_{TD_i}}{w_i} \qquad \text{Eq. 3.34}$$

where TD_i is the total display size in i^{th} equation, and δ_{TD_i} is the coefficient corresponding to total display size in the i^{th} equation.

The total point-of-purchase material elasticity is:

$$\frac{\partial q_i}{\partial POP_i} * \frac{POP_i}{q_i} = \frac{POP_i(1 - \gamma_{ii} \ln p_i)\upsilon_{POP_i}}{w_i} \qquad \text{Eq. 3.35}$$

where POP_i is the total point-of-purchase material in i^{th} equation, and υ_{POP_i} is the coefficient corresponding to point-of-purchase material in the i^{th} equation.

The own-price, cross-price, expenditure, total display size, and total point-of-purchase material elasticities formulas provide a way to determine how a one percent change in each of these variables will affect demand.

3.2 Data

The data set for this study is primary data. The data are weekly consumer purchases aggregated from two retail grocery stores within the same chain. The stores had diverse management styles and were located in different demographic areas in the Portland Oregon metropolitan area.

Weekly data was collected on the sales of fresh hand fruit for forty-four weeks. A total of five different researchers helped in the data collection process throughout the study. Pictures were taken for each display and were cataloged according to week and store.

3.2.1 Data Collected

Store visits included data collection on all apples, pears and other hand fruit.[4] Information collected on individual prices, origin of production, eco-labeling, fruit sizes, display sizes, point-of-purchase material size, and a quality scale for apples, and pears.

Detailed maps of the produce area were taken each week. The maps provided information on the location of apples, pears, other hand fruit and any eco-label signage. It was also noted on the maps if any displays of fresh fruit appeared outside the produce department from week to week. These outside displays were either

[4] Other hand fruit was based on the type of fruit people could eat with little preparation, similar to apples; e.g. oranges and kiwis.

displays located in other sections of the store or actually outside of the main entrance of the store.

Quantity sold was collected from printouts, provided by the produce managers or other qualified personnel within each store. Each printout provided data on total revenue and quantity sold aggregated by week. The printouts would include weekly data dating back for three weeks. A PLU number, codes used by almost all stores to track produce sales, would report each variety of fresh fruit. For example, the number 4016 would appear on the printout. This number reflects large Red Delicious apples. After identifying which PLU numbers were associated with which fresh fruit variety the quantity sold for a give week was recorded.

The hard copies of the data collected have been cataloged and sorted by week. For ease of data analysis the information was manually entered into an Excel spreadsheet. To check for entry errors sub-sets of ten per week were checked for accuracy. If any errors were found the entire weekly entry for the store was double-checked with pictures and the information collected from the store visits.

3.2.2 Data Preparation

Certain variables that were determine to influence consumer-purchasing behaviors for apples and pears went through a preparation stage before they could be included in the model. These variables are quantity sold, display and point-of-purchase material size, quality measures, entry, traffic flow, and product information.

Small and large varieties of apples often appeared in the same store. If there was no product differentiation between the small and large apple varieties, it was determined that the two varieties were being sold as one product. If the two different sizes of apples were determined as being sold as the same product then the quantities sold were combined.

To take into account the fact that multiple researchers were used in collecting the data, the display sizes and point-of-purchase material has been standardized between researchers. Knowing that the dimensions of the product aisles provided information in standardizing the displays and point-of-purchase material sizes between researchers.

The quality measures were based on first hand observations, discussions with produce managers and articles by Ricks et al. (2002), Sterns et al. (1999), Dever et al. (1995), Kappel et al. (1995), and Williams et al. (1977). The quality scale included individual quality measures on bruising, damage, markings, brilliance, and maturity. A four-point scale was used to quantify the different measures of quality. Bruising related to the percentage of overall bruising that was present in a specific display during each store visit. Damage related to the percentage of fruit in a specific display that had holes or cuts that punctured the fruit's skin. Markings related to any abnormalities, such as dirt or waxy build up. Brilliance related how polished the overall display of a specific variety of fruit looked. Maturity related to the percentage of discoloration that was present in a specific display during a weekly store visit. Discoloration reflected the deviations from the expected ground color for a given variety of fruit. Table 3.2 provides the specification for the different quality measures.

The produce department maps provided the information to create an entry variable and variables on aisle location. Information from the maps on whether or not a display of a specific variety appeared in the entryway of the produce department was use in the development of the entry variable. The entry for a produce department was determined to be the first displays that consumers would notice as they moved from the entrance of the store to the entrance of the produce department. The variables created for aisle location were within, end and freestanding. A within display was any display that only had one side that was assessable to consumers. An end display was any display that had two or three sides assessable to consumers. A freestanding display was any display that had four side that were assessable to consumers, these were usually bins placed on the produce department floor.

Interviews were conducted with the produce managers or other qualified personnel to determine traffic flows through each store's produce department. A classification system of high, medium, and low traffic areas were used to classify the corresponding sections that related to high, medium and low movements of product. From the interviews each display for apple, and pear varieties were characterized as being in a high, medium or low traffic flow area to create variables based on traffic flow.

Using the pictures taken during the weekly visits, variables on product information were developed. Product information relates to sensory wording such as fresh, sweet, and crisp. Based on the pictures of the point-of-purchase material for

Table 3.2 Interpretation of Quality Scale Variable

Quality Measure	Scale Value	Interpretation of Scale Values
Bruising	1, 2, 3, 4	1 = More than 50 % of the fruit on display has bruising 2 = 30 to 50 % of the fruit on display has bruising 3 = 10 to 30 % of the fruit on display has bruising 4 = Less than 10 % of the fruit on display has bruising
Markings	1, 2, 3, 4	1 = More than 50 % of the fruit on display has markings 2 = 30 to 50 % of the fruit on display has markings 3 = 10 to 30 % of the fruit on display has markings 4 = Less than 10 % of the fruit on display has markings
Damage	1, 2, 3, 4	1 = More than 50 % of the fruit on display is damaged 2 = 30 to 50 % of the fruit on display is damaged 3 = 10 to 30 % of the fruit on display is damaged 4 = Less than 10 % of the fruit on display is damaged
Brilliance	1, 2, 3, 4	1 = Brilliance of the fruit is dull 2 = Brilliance of the fruit is glossy, which is half way between shiny and dull 3 = Brilliance of the fruit is shiny 4 = Brilliance of the fruit is very shiny
Maturity	1, 2, 3, 4	1 = • 50% of the fruit being green/yellow (Immature) when ground color is yellow/red/brown/green, depending on variety • 50% of the fruit show discolorations (Over ripe) 2 = • The ground color is predominately green/yellow (Immature) with 30 to 50% when ground color is yellow/red/brown/green, depending on variety • 30 to 50 % of the fruit show discolorations (Over ripe) 3 = • The ground color predominately yellow/red/brown/green, depending on variety, with 10 to 30% degree of the ground color being green/yellow. (Immature) • 10 to 30 % of the fruit show discolorations (Over ripe) 4 = • The ground color is yellow/red/brown/green, depending on variety, 0 to 10% degree of the ground color being green/yellow. (Immature) • 0 to 10% of the fruit show discolorations (Over ripe)

each display of a specific variety, product information variables for specific words or groups of words were created.

Numerous variables have been created to be able to accurately model the demand for fresh apples and pears in grocery stores. Table 3.3 provides a list of variables that appear in the demand equations to be estimated, a brief description of the variables, and type.

Equations based on the nonlinear AIDS model were estimated as a seemingly unrelated regression (SUR), with SAS. The SAS program was also used to test and impose the restriction of homogeneity of degree zero, adding-up, and symmetry; and also to test for autocorrelations and significance levels for the variable's estimated coefficients.

3.3 Summary

The aggregated weekly data and weekly store observations were analyzed in an AIDS model using SAS, which incorporated own-price, cross-prices, total display size, total point-of-purchase material, in-store advertisements, bag availability, product information, end displays, seasonality and store differences have on specific varieties of fresh apples and pears. Elasticity estimates will be calculated for price, cross-price, expenditures, total display size, and total point-of-purchase material. The results of the estimated model are presented in the next chapter.

Table 3.3 Regression Variables, Variable Descriptions, The Dates for the Variables appear in the Data Set and the Type of Variable

Variable	Description
Store	Store1 = store 1 Store2 = store 2
Price	Apples, Pears and all other Fruit prices
Quantity	Apple and Pear quantities sold
Origin of Products	Location of products origin of production. Origin locations are Northwest (OR, WA, ID), Washington, Oregon, and International (Any production location not within the U.S.)
Total Display Size	The total display size measured in square inches for each product
Total Point-of-Purchase Material Size	The total size measured in square inches for each point-of-purchase sign associated with a specific product
In-Store Advertising	Variable specifying whether or not a specific product was featured in the in store circular
Availability of Bagged Apples	Variable specifying whether or not a specific bagged product was available in a particular store in a given week.
Product Information	Variable specifying whether or not a specific product had any descriptive wording on the point-of-purchase signage. The descriptive wording could appear on any display and included the words: Fresh, Sweet, Crisp, Juicy, Tasty, Delicious, Scrumptious, Tart, Crunchy, Cool, or Delightful.
End Display	Variable specifying whether or not a specific product was located on the end of a display. The end of a display is referred to any display that had two or three open sides for access by the consumer.
Seasonality	Variable specifying the different seasons. The seasons were determined by the calendar.
Number of Varieties Available	The number of different fruit varieties that appeared each week in the aggregate share equations.
Quality	Quality index assessing the percentage of bruised or damaged that appeared in pear displays
Expenditure Index	Calculated Index to reflect consumers' expenditure levels.

4. EMPIRICAL RESULTS

Modeling consumer purchasing habits for fresh apples and pears in the retail environment must take into account a wide variety of components as discussed in Chapters 1 and 2. Determining the factors significant for fresh apple and pear demand is critical to better understand how different marketing strategies affect consumer-purchasing habits. This chapter reviews and discusses the results of the demand model. Elasticities for price, income, display size, and point-of-purchase material are also presented and discussed.[5] Before these results are presented the model specification is explained.

4.1 Model Specification

The non-linear and Linear Approximation versions of the AIDS model were estimated using SAS. The non-linear AIDS model provided higher adjusted R^2s for the share equations and had stronger relationships between the cross prices then the linear AIDS model. Since it also satisfies theoretical concerns, the non-linear AIDS model was chosen over the linear version, and the prices were normalized.

The other sweet apples, tart apples, pears and other fruit are aggregated quantities with weighted average prices. A share equation for each of the fruit types is included in the non-linear AIDS model with the exception of the share equation for

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[5] The excluded variables are presented in Appendix A. These variables were excluded because of too few non-zero observations, not enough variation in the variables, and/or insignificance of the estimated coefficients.

Other Fruit.[6] It was excluded from the estimated system so that the regression matrix would be non-singular. Table 4.1 maps the variables that are included in each share equation. The estimated coefficients and interpretation of these variables will be discussed later in this chapter.

Table 4.1 Variables Included in the Model by Share Equation

Variables	Share Equations					
	Gala	Fuji	Red Delicious	Other Sweet Apples	Tart Apples	Pears
Price Vector*	X	X	X	X	X	X
Expenditures	X	X	X	X	X	X
Total Display Size	X	X	X	X	X	X
Total Point-of-Purchase Material Size	X	X	X	X	X	X
In-Store Advertising	X	X	X	X	X	X
Availability of Bagged Apples	X	X	X	X	X	
Origin of Products	X	X	X	X	X	X
Product Information	X	X	X	X	X	X
End Display	X	X	X	X		X
Number of Varieties Available				X	X	X
Quality						X
Seasonality	X	X	X	X	X	X
Store Differences	X	X	X	X	X	X

* The price vector consists of the price variables for each fruit type modeled in the system of equations

A Wald test was used to test for symmetry, homogeneity of degree zero, and adding-up in the non-linear AIDS model. The calculated χ^2 statistic for the test on symmetry was 18.33 compared to the critical χ^2 value of 30.58 at a ninety-nine

[6] Refer to Appendix B for details resulting in the selection of the specific apple varieties to model in the share equations.

percent confidence level with fifteen restrictions. The calculated χ^2 statistic is less than the critical value so the null hypothesis that prices are symmetric is not rejected. The results are similar for homogeneity and adding-up, thus the respective null hypotheses are not rejected. The calculated χ^2 for homogeneity is 2.50 compared to the critical χ^2 value of 16.81 at a ninety-nine percent confidence level with six restrictions. The calculated χ^2 for adding-up is 0.02 compared to the critical χ^2 value of 6.63 at a ninety-nine percent confidence level with one restriction. Due to the Wald tests failing to reject the null hypotheses of symmetry, homogeneity of degree zero and adding-up, these restrictions were imposed on the non-linear AIDS model.

The Durbin-Watson statistics for the equations showed that autocorrelation was not present or was undefined. Table 4.2 presents the Durbin-Watson statistics and the critical values. The Durbin-Watson statistics from the model are close to two

Table 4.2 Calculated and Critical Values of the Durbin-Watson Statistic

Share Equation	Calculated Durbin-Watson Statistic	Lower and Upper Critical Values for the Durbin-Watson Statistic
Gala	2.1213	Lower = 1.213 Upper = 2.148
Fuji	1.7003	Lower = 1.213 Upper = 2.148
Red Delicious	2.0998	Lower = 1.213 Upper = 2.148
Other Sweet Apples	2.0239	Lower = 1.187 Upper = 2.179
Tart Apples	1.7225	Lower = 1.187 Upper = 2.179
Pears	2.0964	Lower = 1.160 Upper = 2.211

in all share equations except for Fuji and Tart Apples. The Durbin-Watson statistics for the Fuji and Tart Apples share equations falls into the inconclusive area and because the statistics were approaching two, it was determined there was not a problem with autocorrelation.

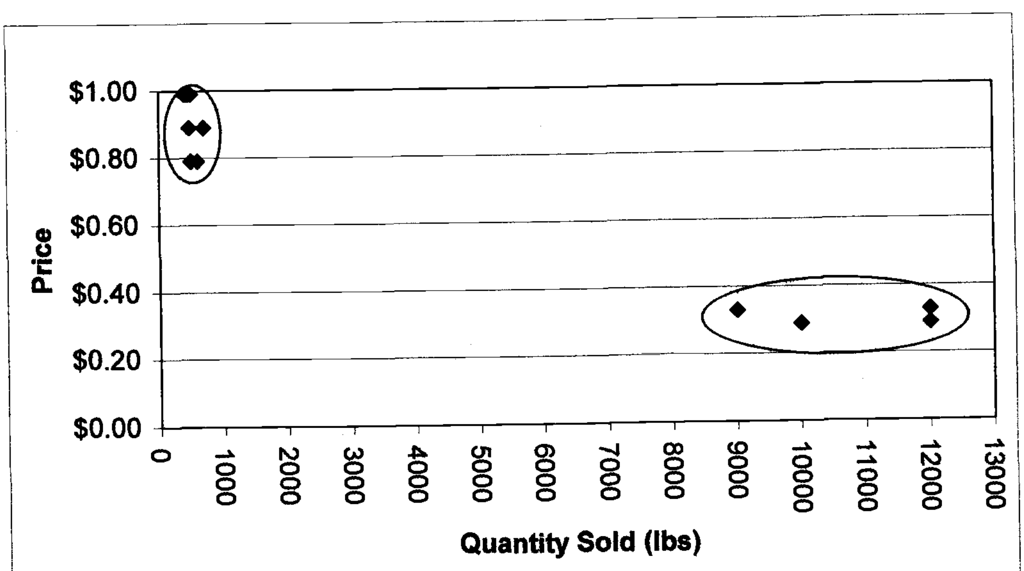
The explanatory power of the share equations for Gala, Red Delicious, Other Sweet Apples, Tart Apples, and Pears is at an acceptable level. The determination of the explanatory power is found by examining the adjusted R^2s. For the share equations that have good explanatory power the adjusted R^2s are high. The share equation for Fuji has the lowest adjusted R^2 as compared to the other share equations. Table 4.3 provides the adjusted R^2 for each share equation in the non-linear AIDS model. The low adjusted R^2 for the Fuji share equation of 0.6442 could result from the exclusion of factors that are important in the Fuji share equations but not in other share equations. However, another explanation for the low adjusted R^2 for the Fuji equation is the harvest of Fuji apples in 2001 was larger then previous years.

Table 4.3 Adjusted R^2 for Share Equations

Share Equation	Adjusted R^2
Gala	0.8633
Fuji	0.6442
Red Delicious	0.8189
Other Sweet Apples	0.8501
Other Tart Apples	0.8033
Pears	0.8777

Two different sales periods were observed for Fuji apples: prices around \$0.99/lb with low to average quantity sold, and low prices with high sales volume. The observations with low prices and high sales may have resulted in an odd slope for the regression, which would result in a lower adjusted R^2. Graph 4.1 provides an example of two different sets of observations. In this example, one set of observations reflects the sales volume with prices around \$0.99/lb, and one set of observations characterized by high sales volume with low prices. Having two different sets can make it difficult for the AIDS model to fit a regression accurately representing observed sales; thus, the result is a lower then expected adjusted R^2, which could explain why the Fuji apples adjusted R^2.

Graph 4.1 An Example of Two Different Observation Sets



The variables that were used in the non-linear AIDS model were variables that proved to be significant in explaining how the share of expenditures varies between fresh apple and pear varieties. Any estimated coefficient is considered significant is significant at a five percent level or less.

4.2 Estimated Price Coefficients and Elasticities

Economic theory specifies that Own-Price estimated coefficients should be negative reflecting that as prices increase for a specific good the quantity sold of that good should decrease. However, this study is based on modeling consumers' purchase habits for specific apple and pear varieties using a share equation model. The estimated coefficient is still expected to be negative, but as the own-price for a specific good increases, the consumers' expenditures, not demand, will decrease for that good.

The Cross-Price estimated coefficients explain which products are substitutes or complements to the dependent variable of the share equation. When the estimated Cross-Price coefficients are positive then products are substitutes. As the price of a substitute product increases the share of expenditures on the product specified in the share equation will increase. If the Cross-Price estimated coefficients are negative then the products are complements, and as price for a complement product increases the share of expenditures for the product specified in the share equation will decrease. Table 4.4 presents the estimated Own and Cross-Price coefficients from the regression model.

As expected the estimated coefficients for Own-Price variables are negative. The estimated Own-Price coefficients are significant for all share equations except for

Table 4.4 Estimated Coefficients and t-values for Price Variables from the Regression Model*

Variables**	Equations					
	Gala	Fuji	Red Delicious	Sweet Apples	Tart Apples	Pears
Logged Gala Price	-0.02615[a] (-4.44)	0.008012[c] (1.86)	0.005972[a] (2.35)	0.002275 (0.44)	-0.00669 (-1.13)	-0.01002[b] (-2.04)
Logged Fuji Price	0.008012[c] (1.86)	-0.02846[a] (-3.12)	0.00086 (0.36)	0.010784[c] (1.78)	0.004301 (0.60)	-0.00616 (-1.21)
Logged Red Delicious Price	0.005972[a] (2.35)	0.00086 (0.36)	-0.01949[a] (-6.36)	0.001623 (0.51)	-0.00243 (-0.74)	-0.00486 (-1.49)
Logged Sweet Apple Price	0.002275 (0.44)	0.010784[c] (1.78)	0.001623 (0.51)	-0.03736[a] (-3.49)	-0.0061 (-0.78)	0.009663 (1.45)
Logged Tart Apple Price	-0.00669 (-1.13)	0.004301 (0.60)	-0.00243 (-0.74)	-0.0061 (-0.78)	-0.04015[a] (-3.19)	-0.0007 (-0.10)
Logged Pear Price	-0.01002[b] (-2.04)	-0.00616 (-1.21)	-0.00486 (-1.49)	0.009663 (1.45)	-0.0007 (-0.10)	-0.01391 (-1.57)
Logged Other Fruit Price	0.026605[a] (3.11)	0.018828 (1.33)	0.01833[a] (4.21)	0.01912 (1.55)	0.051766[a] (3.97)	0.02599[a] (2.65)

* t-values are in parentheses

** [a] represents a one percent level of significance, [b] represents a five percent level of significance, [c] represents a ten percent level of significance pears, although the size of the estimated Own-Price coefficient is similar to that of the apple varieties. There is little variation observed in the price of pears, and this lack of price variation could explain why the Own-Price estimated coefficient is insignificant in the Pears share equation.

The estimated Price coefficients are complex in meaning because prices are in logged form in the AIDS model. For example, a one-unit upward change in logged price, which is unlikely for fresh fruit, would result in greater then a dollar change in expenditure share.

The Cross-Price estimated coefficients showed substitutable and complementary relationships between certain apple varieties and pears. Other fruit were found to be substitutes for Gala apples, Red Delicious apples, tart apples, and pears. Gala apples were found to be substitutes for Red Delicious apples and Fuji apples. Fuji apples were found to be substitutes for other sweet apples. The opposite is true for all substitutes because prices are symmetric in the model. An unexpected result was that pears and Gala apples were found to have a complementary relationship. According to previous studies apples and pears were found to be substitutes for one another.

The Price elasticities provide a better understanding of the relationship between prices and quantity demanded. The estimated Marshallian Own and Cross-Price elasticities are displayed in Table 4.5. Marshallian elasticities explain how a one percent change in prices relates to a percentage change in quantity demanded, holding total expenditures constant. Marshallian elasticities are similar to the

Hicksian elasticities except utility is held constant instead of total. For reference, the estimated Hicksian elasticities are presented in Appendix C.

The Own-Price elasticities were calculated using the mean expenditure share and the mean of the expenditure index. The t-values were calculated for the Own-Price elasticities showing the significance of Own-Price elasticities, but not for the Cross-Price elasticities.[7] The t-values are all high, indicating that the Own-Price elasticities are significant.

Table 4.5 Estimated Marshallian Elasticities from the Regression Model*

Variables	Equations						
	Gala	**Fuji**	**Red Delicious**	**Sweet Apples**	**Tart Apples**	**Pears**	**Other Fruit**
Gala Price	-1.89 (-8.67)	0.40	0.33	0.20	0.01	-0.27	0.88
Fuji Price	0.17	-1.47 (-9.53)	0.04	0.21	0.14	-0.08	0.15
Red Delicious Price	0.44	0.15	-1.89 (-12.82)	0.22	0.18	-0.12	0.78
Sweet Apple Price	0.06	0.18	0.05	-1.52 (-10.30)	0.02	0.17	0.24
Tart Apple Price	0.00	0.17	0.06	0.01	-1.44 (-8.10)	0.11	0.78
Pear Price	-0.13	-0.08	-0.05	0.20	0.07	-1.20 (-8.44)	0.39
Other Fruit Price	0.01	-0.00	0.00	0.00	0.01	0.01	-1.18

* t-value are in parentheses

[7] The t-values for the Cross-Price elasticities are difficult to calculate and are beyond the scope of this study.

The Own-Price elasticities show how a one percent change in own-price will impact the quantity demanded of a specific apple or pear variety. All of the Own-Price elasticities are significant at the one percent level and elastic, indicating a greater then one percent change in quantity demanded when price is changed by one percent. The Own-Price elasticity for Gala is -1.89, which indicates that if the price for Gala apples increased by one percent then the quantity demanded for Gala apples would decrease by 1.89 percent. The elasticity results are similar for the other Own-Price elasticities.

There is not a calculated t-value for the Other Fruit Own-Price elasticity because the share equation for Other Fruit was excluded from the model. The estimated elasticity for Other Fruit was calculated by invoking the principal that the expenditure means for each of the share equations must sum to one. From this principal the mean expenditure level for Other Fruit was calculated by taking one minus the other share equations' expenditure means. With a representation for the mean expenditure level for Other Fruit the elasticity was calculated in the same manner as the other share equations.

The Cross-Price elasticities show how a one percent change in another product's price relates to a percentage change in quantity demanded for a specific product. An example of the Cross-Price elasticities is if the price of Fuji apples increases by one percent, then the quantity demanded for other sweet apples would increase by 0.21 percent. The Cross-Price elasticities for Gala, Fuji, Red Delicious, other sweet apples, tart apples and pears are inelastic. The term inelastic refers to a one percent change in price resulting in less then a one percent change in quantity demanded. The sizes of the estimated Cross-Price elasticities are small for all apple and pear varieties, which indicate that changes in the prices between substitutable apples and pears will have little affect on the demand for specific apple or pear varieties. In the Other Fruit share equation half of the Cross-Price elasticities are close to one or unit elastic. Unit elastic refers to a one percent change in prices that results in a one percent change quantity demanded.

The fruit varieties that were found to be substitutes or complements for each other have inelastic Cross-Price elasticities. Based on the estimated Cross-Price elasticities, prices for Gala, Red Delicious, and tart apples will have an impact on the demand for other fruit. Even though the elasticities are inelastic, the estimated values are close to one so with a one percent change in the price of Gala, Red Delicious, or tart apples will increase the demand of other fruit by close to one percent. Gala apples and pears were found to be complements, but the Cross-Price elasticity is 0.27. So changes in prices for Gala apples or pears will have little impact on the quantity of pears or Gala apples demanded.

Most apple and pear varieties were found to be substitutes for one another, except for Gala apples and pears. There appears to be a significant complementary relationship between Gala apples and pears, which is an unexpected result. More research is warranted with respect to how consumers choose between pears and Gala apples. Different apple and pear varieties are substitutes or complements for each other, but the Cross-Price elasticities show that changes in substitute or complement prices will have little impact on the level of expenditures for apples or pears.

4.3 Estimated Expenditure Coefficients and Elasticities

The Expenditure variable is used to represent expenditure impacts within the AIDS model. Due to the nature of the data, information on consumer income was not available; so only expenditure effects are possible. The data set for the study may not accurately reflect a change in total expenditure, because only forty-four weeks are represented by the data. Since the data was collected over a short period, changes in consumers' expenditures may not be reflected. If the data set covered multiple years then results on expenditure levels might be different.

The estimated coefficients that correspond to the Expenditure variable used in the non-linear AIDS model illustrate what goods are luxuries versus necessities. In Table 4.6 the estimated Expenditure coefficients are presented. Goods, which are luxuries, will have a positive estimated coefficient and goods, which are necessities, will have a negative estimated coefficient. Estimated Expenditure coefficients for all apple and pear varieties are negative, so they are considered necessities.

Table 4.6 Estimated Expenditure Coefficients from the Regression Model*

Variables	Equations					
	Gala	Fuji	Red Delicious	Sweet Apples	Tart Apples	Pears
Expenditure**	-0.017[a] (-2.76)	-0.011 (0.83)	-0.015[a] (-5.38)	-0.012 (-1.35)	-0.039[a] (-4.68)	-0.013[c] (-1.86)

* t-values are in parentheses

** [a] represents a one percent level of significance, [b] represents a five percent level of significance, [c] represents a ten percent level of significance

The Expenditure elasticities illustrates changes in quantity demanded implies quantity us able to take action when the total level of expenditure for fresh fruit changes. These elasticities are provided in Table 4.7. If consumers' expenditure level for fresh fruit increased then there would be little impact on the share of expenditures for Gala, Red Delicious, and tart apple varieties as their elasticities are all less then 0.35. This means that as consumers' expenditure levels for all fresh fruit increases by one percent, the quantity demanded for these apple varieties would increase by less then one half of a percent. However, if consumer expenditure levels were to increase for fresh fruit then there would be a noticeable affect on Fuji, other sweet apples, pears, and other fruit. The elasticities for these fruit groups are close to or greater than one.

Table 4.7 Estimated Expenditure Elasticities from the Regression Model*

Variables	Equations						
	Gala	**Fuji**	**Red Delicious**	**Sweet Apples**	**Tart Apples**	**Pears**	**Other Fruit**
Expenditure	0.34	0.85	0.24	0.83	0.30	0.79	1.15

*Calculated at the mean levels of expenditures

4.4 Estimated Non-Price Coefficients

The non-price variables that appear in each share equation are those variables according to the literature that are important in modeling consumer purchase habits for fresh fruit. Variables that proved to be of interest in the retail environment are Total Display Size, Total Point-of-Purchase Material Size, In-Store Advertising, Availability of Bagged Apples, Origin of Products, Product Information, End Displays, Number of Varieties Available, Quality, Seasonality, and Store Differences. Cross-non-price estimated coefficients were insignificant so they were excluded from the final model. As a result no cross-non-price variable elasticities were calculated. Table 4.8 displays the non-price variables that appear in each share equation. A modification was made to the binary variables associated with aggregated Other Sweet Apples, aggregated Tart Apples, and aggregated Pears share equations. The modification was made to reflect the weighted averages of total display size for each variety in the aggregated groups. For example, if only two varieties of pears were available, one produced in Oregon and the other produced internationally, then the Oregon binary variable would be 0.5. The International variable would also be 0.5 for that observation. This division only occurred if the display sizes were of equal size for each pear variety. Also, for all binary variables no elasticities are calculated.[8] In the next sections the non-price variables are discussed.

4.4.1 Total Display Size Results and Elasticities

Display sizes were measured in square inches and multiple displays were summed when present to create the variable for Total Display Size. The Total Display Size estimates were multiplied by one hundred to represent one hundred square inch changes in total display size. Both logged and non-logged versions of the Total Display Size variable were attempted in the model; since the non-logged

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[8] The elasticities for binary variables are difficult to calculate and are beyond the scope of this study.

Table 4.8 Estimated Coefficients and t-values for the Non-Price Variables from the Regression Model*

Variables	Equations					
	Gala	Fuji	Red Delicious	Sweet Apples	Tart Apples	Pears
Intercept	0.153924[a] (2.65)	0.074677 (0.88)	0.147915[a] (5.57)	0.168417[b] (2.08)	0.37969[a] (4.73)	0.075377 (1.08)
Total Display Size For (100 Inches)	0.000267 (1.36)	0.0003287 (1.52)	0.0004247[a] (3.91)	0.0003889[a] (4.40)	0.00029[a] (3.86)	0.0008657[a] (6.53)
Logged Total POP For (Inches)	0.011899[a] (2.77)	0.008189[b] (2.14)	0.001651[c] (1.67)	-0.00046 (-0.13)	0.003921 (1.40)	0.006939[b] (2.05)
Ad	0.014763[a] (3.41)	0.017276[a] (3.03)	0.001311 (1.18)	0.005007 (1.36)	-0.00482 (-1.48)	0.012193[a] (4.78)
Bag Availability	0.000895 (0.19)	-0.00311 (-0.62)	-0.00311[b] (-2.33)	-0.00496 (-1.03)	-0.00308 (-0.72)	
International					-0.00456 (-0.45)	-0.01595 (-1.41)
Northwest	0.004809 (1.15)	-0.0026 (-0.61)				
Oregon						-0.00915 (-1.21)
USA Pear Logo						0.055918[a] (3.10)
Washington			0.002499[b] (2.14)	-0.0317[a] (-3.96)	-0.00678 (-0.97)	
Descriptive Wording	-0.02004[a] (-3.77)	-0.00759 (-0.97)	-0.00041 (-0.18)	0.016503[a] (3.38)	0.017821[a] (3.76)	0.008696[b] (2.23)

Table 4.8 Estimated Coefficients and t-values for the Non-Price Variables from the Regression Model (cont.)

Variables	Equations					
	Gala	Fuji	Red Delicious	Sweet Apples	Tart Apples	Pears
End	0.002098 (0.25)	0.019496[a] (3.30)	0.000299 (0.15)	0.024306[a] (4.35)		-0.00024 (-0.06)
Total Sweet Apples				-0.00297 (-1.23)		
Total Tart Apples					0.003468 (1.33)	
Total Pears						-0.00148 (-0.91)
Bruising & Damage						0.004566[b] (2.30)
Fall	-0.02592[a] (-5.31)	0.012619[c] (1.94)	0.004828[b] (2.36)	0.015965[b] (1.92)	-0.01072[b] (-1.68)	-0.01395[b] (-1.82)
Winter	-0.02394[a] (-4.93)	0.024155[a] (3.36)	0.001316 (0.65)	-0.00425 (-0.61)	-0.00603 (-0.92)	-0.01333[b] (-2.07)
Spring	-0.02609[a] (-5.96)	0.021696[a] (3.24)	0.001987 (1.08)	0.000685 (0.12)	-0.00473 (-0.69)	-0.01174[b] (-2.39)
Store 3	-0.0162[a] (-1.87)	0.007368 (1.07)	-0.01133[c] (-5.24)	-0.00564 (-0.80)	0.001561 (0.20)	-0.00109 (-0.23)

* t-values are in parenthesis

version of total display size had superior explanatory power, it was included in the model.

Total Display Size is significant in the Red Delicious, Other Sweet Apples, Tart Apples and Pears share equations. An interpretation of the Total Display Size estimated coefficient is if total display size for tart apples were increased by one hundred square inches then the share of expenditures on tart apples would increase by 0.029 percentage points. All of the coefficients corresponding with Total Display Size are positive. Therefore, the more display area that a specific product has the greater the probability that consumers will see the product and purchase it.

In the Gala and Fuji share equations, the Total Display Size estimated coefficients are insignificant. The estimated coefficients are similar in value to other apple varieties Total Display Size estimated coefficients. The low significance level could be caused by the lack of variation in the Gala and Fuji apples Total Display Size variables. This lack of variation could be caused because produce managers do not change displays from week to week often, and when displays were moved it usually corresponded to a seasonal change.

The elasticities for each share equation's Total Display Size, which are presented in Table 4.9, are inelastic. The interpretation of the Total Display Size elasticities is if the total display size for Gala apples increases by one percent then the percentage change in the share of expenditures on Gala apples would increase by 0.18 percent.

Table 4.9 Estimated Elasticities for Total Display Size and Point-of-purchase Signage from the Regression Model

Variables	Equations					
	Gala	Fuji	Red Delicious	Sweet Apples	Tart Apples	Pears
Total Display Size For	0.18	0.12	0.24	0.29	0.22	0.69
Total Point-of-purchase Signage For	2.17	0.68	0.35	-0.04	0.44	0.72

4.4.2 Total Point-of-Purchase Material Size Estimates and Elasticities

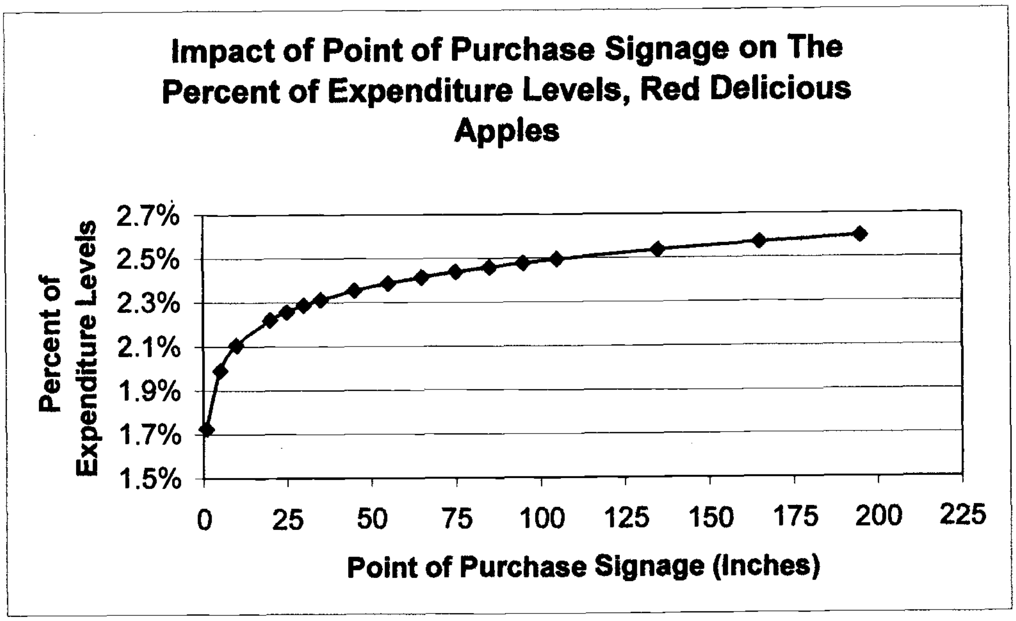
Point-of-purchase material relates to those signs on displays informing consumers about prices and other product information. Each point-of-purchase sign was measured in square inches, and summed when multiple signs were observed, to create the Total Point-of-Purchase Material Size variable. One would expect that the estimated coefficients for Total Point-of-Purchase Material Size would be positive and significant in each share equation. The more point-of-purchase material that is viewable by consumers should translate to a greater chance that consumers notice the product and purchase it.

The Total Point-of-Purchase Material Size variable in the model is in a logged form. This result from trials of both log and non-logged versions of the Total Point-of-Purchase Material Size variable being tested, and the logged version having stronger t-values and increased the adjusted R^2 values for each share equation.

Total Point-of-Purchase Material Size estimated coefficients are significant in the Gala, Fuji and Pear share equations. In the Red Delicious apple share equation, Total Point-of-Purchase Material size estimated coefficient is significant to a ten percent level. Examining the elasticities, in Table 4.9 on page 68, reveals that increasing point-of-purchase material size will have little impact on the share of expenditure levels for apple and pear varieties except for Gala apples. Increasing the point-of-purchase material size for Gala apples by one percent will result in a 2.17 percent increase in quantity of Gala apples demanded.

A dynamic picture of the elasticity for Total Point-of-Purchase Material Size explains the true impact point-of-purchase has. From a logical standpoint the impact of the Total Point-of-Purchase Material Size variable should increase at a decreasing rate. Graph 4.2 provides an example of how increasing the size of point-of-purchase material relates to the percentage of expenditure levels for Red Delicious apples. The graph shows that increasing the size of point-of-purchase material past one hundred square inches will have little impact on increasing expenditure levels, whereas increasing the size of point-of-purchase material from zero up to one hundred square inches will have a large impact on expenditure levels for Red Delicious apples.

Graph 4.2 Example of Increasing the Size Point-of-Purchase Material with Respect to the Percentage of Expenditure Levels for Red Delicious Apples



4.4.3 In-Store Advertising

The In-Store Advertising variable included in this study is based on information from the weekly in-store flier. Products that were featured in the in-store flier were considered in-store advertisements. The fliers were not mailed out to consumers, or inserted in local newspapers so consumers only had access to the advertisements at the store or through the store's website. The variable is a binary representation when a product was featured.

An interpretation of the In-Store Advertisement variable is that if Gala apples were featured then the share of expenditures on Gala apples would increase by 1.48 percentage points. For the Pears share equation the coefficient with the In-Store Advertisement variable means that if all pears were featured then the share of aggregated expenditure on pears would increase by 1.22 percentage points. In the Gala, Fuji and Pears share equation the In-Store Advertisement coefficients are significant.

The In-Store Advertisement estimated coefficients are presented in Table 4.8 on page 65. The estimated coefficients are positive, reflecting a positive increase in the share of expenditures for those fresh apple and pear varieties when they were featured. This relationship was expected. In-Store Advertisement estimated coefficients are insignificant in the Red Delicious, Other Sweet Apples and Tart Apples share equations. An explanation for Red Delicious apples In-Store Advertising coefficient being insignificant is that whenever Red Delicious apples were featured similar sweet apples were featured at the same price. When Red Delicious apples are featured at the same price as other sweet apple varieties, consumers would favor the other sweet apple varieties, instead of Red Delicious apples.

4.4.4 Availability of Bagged Apples

The Availability of Bagged Apples variable reflects whether or not a bag of the same variety of bulk apples were available during the same week. The Availability of Bagged Apples estimated coefficients are only significant in the Red Delicious share equation; though in the Fuji and Other Sweet Apples share equations the availability of bagged apples estimated coefficients are similar in value but not significant. Therefore, if a bag of Red Delicious apples were available in a given week, the share of expenditures on bulk Red Delicious apples would decrease by 0.31 percentage points. The bags are substitutes for bulk Red Delicious apples in the consumers mind. However, consumers view bagged apples as lower quality apples, or as inferior products. Having bagged Red Delicious apples being substitutes for bulk Red Delicious apples means that consumers also view bulk Red Delicious apples as an inferior apple.

During the data collection period not all varieties of apples had a bagged apple substitute, so consumers may not expect a bag alternative to be present in the store every week. Also, the bagged apple substitutes were not located near the bulk apples. Unless consumers were planning to buy bagged apples, they are not likely to notice the bagged alternative when shopping for bulk apples.

4.4.5 Product Origin

The origin of production variables were determined by the labeling that appeared with specific varieties of fresh fruit. The labeling was in the form of stickers or information on the point-of-purchase material. Origin of production is represented through variables, which included Oregon, Washington, the Northwest, International and products that used the USA Pear Logo, where appropriate.[9]

The estimated coefficient for the USA Pear Logo sticker in the Pears share equation is significant at a one percent level, which means if all of the pear varieties

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[9] The Pear Bureau Northwest uses a USA Pear logo sticker to promote fresh pears grown in Oregon and Washington. The Pear Bureau Northwest was established in 1931 as a non-profit marketing organization to promote, advertise and develop markets for pears from Oregon and Washington.

were to have the USA Pear Logo sticker on them, the share of expenditures for pears would increase by 5.56 percentage points. The estimated coefficient for the Washington variable is significant in the Red Delicious and Other Sweet Apples share equations. The Washington variable in the Red Delicious and Other Sweet Apples share equations has opposite effects. In the Red Delicious share equation, if Red Delicious apples were labeled as being from Washington, then the share of expenditures on Red Delicious apples would increase by 0.25 percentage points.

The Washington label is not effective in increasing the share of expenditure levels for other sweet apples. In the Other Sweet Apples share equation, if all of the other sweet apples were labeled as being from Washington (i.e. the variable is equal to one) then the share of expenditures on other sweet apples would decrease by 3.17 percentage points. Consumers may be unclear about the characteristics of the newer varieties of sweet apples. Consumers may not have the same level of familiarity with other sweet apples branded as a Washington product as they do with Red Delicious apples, or they may prefer other sweet apples that are locally grown.

The Oregon, Northwest and International origin of production estimated coefficients are insignificant. Therefore, consumers appear indifferent between apples and pears produced from these areas and those that provide no information on their origin of production.

4.4.6 Product Information

The Product Information variable reflects descriptive wording used on the point-of-purchase material to describe the characteristics of a given product. The possible descriptive words that could appear are fresh, sweet, crisp, juicy, tasty, delicious, scrumptious, tart, crunchy, cool, or delightful. If any other these descriptive words appeared on the point-of-purchase material for a specific fruit then the observation for product information would have a one for the value and if no descriptive words appeared on the point-of-purchase material then the observation would have a zero for the value.

The Product Information estimated coefficients are significant in the Gala, Other Sweet Apples, Tart Apples and Pears share equations. The estimated Product Information coefficients are insignificant in the Fuji and Red Delicious share equations.

An unexpected result is the negative impact the use of product information has on the share of expenditures for Gala apples. The use of product information increased the share of expenditures on other sweet apples, tart apples and pears. Examining the frequency of the descriptive wording that appeared for Gala apples, other sweet apples, tart apples and pears reveal that only one predominate descriptive word was used on Gala apples point-of-purchase material. Scrumptious appeared thirty-four times, which is far higher then the other descriptive words tasty and sweet, which appear ten and three times, respectively. For other sweet apples, tart apples and pears a much wider range of descriptive wording was used with not one of the words appearing predominately.

Product information on the point-of-purchase material can increase the expenditure levels on other sweet apples, tart apples and pears. The use of product information appears to influence consumers' decisions for these fruit groups. However, using one predominate descriptive word appears to decrease the expenditure levels as in the case for Gala apples. But, more research would need to be done before this conclusion can be made.

4.4.7 End Display

An end display is defined as one that has two or three sides that are available to the consumer; it is usually found at the end of an aisle. Tart apples never appeared in an end display so the End Display variable does not appear in the Tart Apples share equation.

In the Fuji and Other Sweet Apples share equations the End Display estimated coefficient is significant at a one percent level. The End Display estimated coefficients were insignificant in the Gala, Red Delicious and Pears share equations. Gala apples and pears were primarily placed in end displays in one store so little variation was observed. The End Display estimated coefficient for Fuji apples indicates that the quantity demanded would increase by 1.95 percentage points if they appeared in an end display.

4.4.8 Number of Varieties Available

The number of different varieties appearing each week in the aggregated fruit groups (other sweet apples, tart apples and pears) is included in their respective share equations. This variable was included to test whether the number of possible choices in these three fruit categories would have a positive or negative impact on expenditure levels.

The estimated coefficients for the Number of Varieties Available estimated coefficients are insignificant in the all of the aggregated share equations. One explanation for this result is that when a greater number of similar varieties are available, consumers substitute between them. This lends support for aggregating these varieties in analysis, as done in this study.

4.4.9 Quality

A quality scale was used to determine if quality influences consumers' purchasing habits. A four-point quality scale was developed to document the percentage of damage (i.e. punctures of the skin) and bruising that was present in the bulk bins of apples and pears (4 = little bruising or damage, 1 = high amounts of bruising or damage). Damage and bruising were measured separately and then combined to add variation to the Quality variable.[10]

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[10] More information on the quality scale is presented in Appendix E.

The Quality estimated coefficient in the Pears share equation is positive and significant. Pears are more fragile than apples so bruising and damage is more extensive. Consumers are more likely to increase their share of expenditures on pears that do not appear to be bruised or damaged. The damage and bruising variable was excluded from apple share equations because it was insignificant. Apples are not as fragile as pears and do not bruise or damage easily, leaving less variation in the Quality variable for apples.

4.4.10 Seasonality

Spring equinox, summer solstice, autumn equinox, and the winter solstice are used to determine the breaks for each season. The summer season is excluded from the model to avoid the dummy variable trap.

There are seasonal differences in all of the share equations. The Gala share equation's estimated coefficients for each season are significant to a one percent level, where summer appeared to be the time of year that has the greatest impact on expenditures. The Winter and Spring estimated coefficients in the Fuji share equation are significant, with winter having the greatest positive impact on the share of expenditures. The estimated coefficients for Fall are significant in the Red Delicious, Other Sweet Apples, and Tart Apples share equations. For these apple groups fall appears to have the greatest positive impact on expenditures. Fall, Winter and Spring estimated coefficients are significant in the Pears share equation, and summer appears to have the greatest increase on the share of expenditures for pears. This later finding could be a result of the Bartlett harvest. During the summer months Bartlett pears begin to appear at the retail level giving consumers an alternative pear variety to buy.

4.4.11 Store Differences

The data used in the non-linear AIDS model was collected from two different stores. The estimated coefficients for the Store Differences indicate that Red Delicious apples and Gala apples have higher share of expenditures at Store 1. The estimated coefficients in the other share equations do not reflect any significant differences in the level of expenditures between the stores.

4.5 Summary

This study found the expected results for the demand variables. The estimated Own-Price coefficients were negative, most of the estimated Cross-Price coefficients indicated substitutability between some apple and pear varieties and a complementary relationship between others. The Price elasticities showed that a one percent increase in own-price would have a greater then one percent decrease in the quantity demanded for each of the share equations. The Cross-Price elasticities were inelastic for all apple and pear varieties with the highest value being 0.44 between Gala and Red Delicious apples. The Cross-Price elasticities for other fruit were found to be inelastic except for the relationship between Gala, Red Delicious, tart apples and other fruit, which, are nearly unit elastic.

The results for the non-price variables provide information not available in previous studies. Since this study used individual store retail data, it was possible to collect information on the effects of display size and the size of point-of-purchase material. Other demand studies on fruit purchases have not incorporated this information.

Total display size was demonstrated to have a small but significant effect on the share of expenditures. While the Total Display Size estimated coefficients were not significant for Gala and Fuji, the Total Point-of-Purchase Material Size estimated coefficients were significant and positive for these two varieties. The elasticities for Total Display Size were positive and inelastic. The elasticities for Total Point-of-Purchase Material Size were positive and inelastic for Fuji, Red Delicious, tart apples and pears. The elasticity was negative and inelastic for other sweet apples. The elasticity for Total Point-of-Purchase Material Size for Gala apples was positive and elastic.

The use of in-store advertising displayed a significant positive result on Gala, Fuji and pears. Usage of a label stating where a product was produced only had a significant positive effect on pears and Red Delicious when the USA Pear Logo and Washington label were used, respectively. Other branding techniques were either insignificant or reduced the share of expenditures as in the case of the Washington label in the Other Sweet Apples share equation.

Product information had mixed results. The use of a variety of descriptive wording had a significant positive result on pears, other sweet apples and on tart apples. Using one predominate descriptive word appears to have a negative result on quantity demanded. The Quality estimated coefficient was found to be significant and positive for pears. Pears that had little or no bruising and damage increased the share of consumers' expenditures on them.

This study found some marketing strategies help to increase the share of expenditures on specific varieties of fresh apples and pears. Other marketing strategies were insignificant or had a negative effect on the share of expenditures. These insignificant and negative results could be due to little variation in the respective variables. This makes it hard to be confident that these variables do not influence the demand for apples or pears.

5. CONCLUSIONS

The findings of this thesis illustrate that different marketing strategies in the produce department have varying effects on consumers' purchasing behaviors for fresh apples and pears. In this chapter, the results from the regression model and elasticities are revisited with respect to implications for produce managers. Recommendations for future research are provided at the end of this chapter.

5.1 The Model

A non-linear AIDS model was selected to model the regressions of Gala, Fuji, Red Delicious, Other Sweet Apples, Tart Apples and Pears share equations. Each of the share equations' adjusted R^2s were greater then 0.80, except for the Fuji equation. The adjusted R^2 for the Fuji equation is probably because of the unprecedented harvest for Fuji apples in 2001 cropping year. As a result of the 2001 harvest, the prices and quantity of Fuji apples sold did not accurately reflect normal weekly sales. Own-Price estimated coefficients in all equations were negative, which shows that the model confirms to the theoretical relationship between prices and quantity demanded. Based on these results, it is determined that the non-linear AIDS model is a good choice for modeling seemingly unrelated regressions of aggregated weekly data for fresh fruit at the retail level.

5.2 Prices

As stated in the previous section, the Own-Price estimated coefficients were negative across share equations. Findings on substitutes for apples and pears agreed with the findings from previous studies that fresh apple and pear varieties are substitutes for one another. An unexpected result was found that Gala apples have a complementary relationship with pears. Based on previous research, these goods should have a substitutability relationship. Therefore, more research needs to be done to further examine the relationship between Gala apples and pears. The Cross-Price elasticities show that a one percent change in price will have little impact on the quantity demanded for substitutable or complimentary goods. However, changes in own-price will have a larger impact on the share of expenditures for a given good. Produce managers can note that own-price changes will result in large changes in the quantity of apples and pears demanded, but the own-price change will have a relatively small impact on the quantity of other apples and pears demanded.

5.3 Expenditures

The data used in this study did not include information on consumers' income. However using the AIDS model, consumers' expenditure levels for fresh apples and pears was captured. The estimated Expenditure coefficients illustrate that apples and pears are considered necessities, so the quantity of apples and pears demanded will be relatively unaffected by changes in consumers' expenditures for all fresh fruit. In other words, with an increase in expenditure levels for fresh fruit, consumers will continue to buy apples and pears at similar levels as before the increase. Consumers will increase their expenditures on other fresh fruit varieties, which had an elastic Expenditure elasticity. Therefore, during periods when consumers experience increased expenditure levels for all fresh fruit, such as holidays, produce managers may wish to focus their attention on other fruit besides apples and pears.

5.4 Non-Price Variables

Other factors besides price and expenditures affect consumer-purchasing behaviors for apples and pears. Total Display Size, Total Point-of-Purchase Material Size, Origin of Products, Quality, End Displays, Seasonality, and In-Store Advertisements all had positive impacts on certain shares of expenditures for fresh apples and pears.

Increasing display size does increase the share of expenditures for certain varieties of fresh apples and pears. Although, small increases in display size will have little impact on the quantity demanded for apples or pears. Increasing the width of a display by a few inches can result in a significant increase in display size, which, would result in an increase in the quantity demanded. For example, a normal display for Red Delicious apples is approximately 32x19. If the width of this display was increased by three inches the display size would increase by about one hundred square inches, which is a fifteen percent increase in display size. If the width of a normal display size for Red Delicious apples were increased by three inches then the produce managers would expect to see an increase of almost four percent for the quantity demanded for Red Delicious apples.

Another productive way to increase the share of expenditures for apple and pear varieties would be to increase the number of point-of-purchase signs or increase the size of the signs. Generic point-of-purchase material provides consumers with the product name and price. More signs or larger ones will increase the probability that consumers will notice the point-of-purchase for apple and pear varieties, resulting in a higher probability of purchase of those fresh apple or pear varieties. The relationship between point-of-purchase material size and quantity sold is increasing at a decreasing rate. Therefore, increasing the point-of-purchase material area will have a significant impact on the quantity sold up to one hundred square inches. When the point-of-purchase material is increased above one hundred square inches, the point-of-purchase material will have little impact on quantity sold.

The results on the Product Information variable reveals that having a variety of descriptive wording about the characteristics of apple and pear varieties included on the point-of-purchase material increases the share of expenditures for those fresh apple and pear varieties. Using one predominate descriptive word appears to reduce the share of expenditures, which is the case in the Gala apple share equation. Varying the descriptive wording that appears on the point-of-purchase material can increase the knowledge base for consumers. Also, varying the descriptive wording on the point-of-purchase material can attract new consumers that may not have noticed other descriptive wording.

The use of information on origin of products is an effective way of increasing the share of expenditures on Red Delicious apples and pears. Consumers have brand recognition for Red Delicious apples that are produced in Washington and pears that are branded with the Northwest Pear Bureau's USA Pear Logo. The branding for all other apple varieties, regardless of type, was insignificant or negative in the model.

A bin of noticeably bruised or damaged pears decreases the share of expenditures consumers will spend on pears. The same result is not true for apples. This finding is likely due to the fact that it is more difficult to notice bruised or damaged apples as consumers need to get closer to the apple displays to notice any bruising or damage. Once they are close enough to realize that some of the apples are bruised or damaged, they also notice that some of the apples are good. Consumers apparently are willing to sort through bruised or damaged apples to find ones that are not. Consumers do not appear to have the same purchasing behaviors with pears. The implications for produce managers are that they should prepare displays of fresh pear varieties that are free of any bruised or damaged pears. In addition, produce managers should increase the frequency that each pear display is inspected to remove any bruised or damaged fruit. Similarly, produce managers may be able to reduce the frequency that apple displays are inspected.

As the seasons change so do consumers' selection of different apple and pear varieties. The share of expenditures is higher for Gala apples, tart apples and pears in the summer. Consumers' share of expenditures on Fuji apples is greater in the winter and for Red Delicious, and for other sweet apples the share of expenditures is greater in the fall. Knowing consumers' behavior with respect to the season, produce managers can use this knowledge to increase the sales of the produce department. For example, if a produce manager gets a deal on an off-season apple or pear variety, placement of off-season fruit next to in-season fruit will position the product next to items consumers, according to the season, maybe looking for. Placement of off-season products next to in-season products can increase the probability that consumers will notice the product and purchase it. This could result in increasing the overall sales of the produce department.

Store advertisements are an effective way to increase the share of expenditures for fresh apples and pears that are not planned purchases or inferior goods. The use of in-store advertisement for tart apples and Red Delicious apples had an unexpected result. The estimated store advertisement coefficient is insignificant for Red Delicious and tart apples. Consumers may view Red Delicious apples as an inferior apple, because bagged Red Delicious apples, which are considered an inferior product by the consumer, are substitutes to bulk Red Delicious apples. Given this case, the use of in-store advertising will not have the same affect on Red Delicious apples as other apple varieties.

Tart apples are primarily used for baking. They are likely a planned purchase item for most consumers. It follows that most consumers know they need tart apples before entering the store; this scenario would explain why the use of marketing strategies targeting impulse behaviors for tart apples has little impact their demand.

5.5 Future Research

As far as could be determined, this study is the first to look at aggregated weekly data for individual stores and incorporate weekly store observations to determine how different marketing strategies affect consumers' purchasing behaviors for fresh apples and pears. Data on display and point-of-purchase material, product placement, product information and product quality was not readily available from previous studies. After analyzing the data, some limitations were noted and should be corrected for future research.

First, the current data set only extends forty-four weeks from two different stores. Having observations spanning multiple years from numerous stores would help to resolve problems with abnormal years, such as noted with the impact of the large Fuji harvest in 2001. Having data from just a portion of one year does not fully reflect how changes in consumers' expenditure levels affect purchasing behaviors, and may over emphasize seasonal factors. Forty-four weeks of observations on consumers' expenditure levels may not accurately reflect the actual impact purchasing behaviors have on expenditure levels. Also, the use of a longer data set could help by adding more observations, which could provide more variation in the explanatory variables improving estimation and test results.

Second, this study examined the marketing strategies for a conventional grocery store environment, which resulted in some variables having little variation. No input by the researcher was provided to the produce managers, and some variables experienced little variation. Because of little to no variation, some variables were excluded from the model. Therefore, incorporating a random block model for the different marketing strategies that produce managers use would provide calculated variation in the variables and would allow for more statistically sound analysis.

Third, taking one weekly observation on quality may not accurately reflect how apple and pear quality affects demand. The quality observations used in this study were only taken once a week. These observations of quality were used in the analysis for the sales of the entire week. Discussions with produce staff members indicated that each display is inspected twice a day, though the timing was not fixed. During these inspections the displays are refilled and any poor quality produce is removed. Thus, the measurement of quality for the study may not fully reflect the average quality of fruit during the period. Taking more observations during a given week could help to obtain a better representation of how fluctuations in apple and pear quality affect demand.

5.6 Summary

This study is unique as it incorporated an economic demand system analysis using individual weekly store data to determine how marketing strategies used by produce managers affect consumer-purchasing behaviors for fresh apples and pears. This study provides insight into how decisions on price, display sizes, point-of-purchase material, product information, product branding, seasonality, produce quality, in-store advertising, and product placement relate to the share of expenditures for apples and pears. The resulting analysis also indicates promise for future research in determining the factors affecting the demand for apples and pears at the retail level.

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APPENDICES

Appendix A. Excluded Variables

This appendix reports on other variables that were examined, but excluded from the model because of too many zero observations or for insignificant estimated coefficients.

Quality Variables for Apples

Quality information was collected on bruising, markings, damage, brilliance and maturity. These variables were included in each share equation and for the aggregated share equations a weighted average for each quality measure was used. The use of the quality variables was not significant across apple share equations. One quality variable would appear significant in one share equation and insignificant across other apple share equations. The problem with the quality variables for apples was the little variation within these variables. The quality observations where either a three or a four and rarely would a value of two or one appear.

Different combinations of quality variables for apples were tried and the results were similar to those noted above. Bruising, marking and damage were summed. These variables were summed because the quality aspects are similar. The new variable of the summed three quality variables was created to hopefully increase variation. The estimated coefficients for the summed bruising, marking and damage variables were insignificant, resulting in this variable being excluded.

The last attempt at including a quality measure in the share equations for apples was to create a variable that summed all five of the different quality measures.

It was hoped that the summed variable of the five quality measures would add variation to the quality variables that was not captured by the other quality variables noted above. However, this variable also resulted in insignificant impacts and was also excluded from the model. After all these different combinations of the quality scales had been tried and found to be insignificant, the quality scale measures were excluded from the apple share equations. The same variations for quality variables were attempted in the pear share equation and were found to be insignificant, except for damage and bruising. Quality is believed to be an important factor in determining consumer-purchasing patterns but there were few observations of low quality apples in the stores sampled, or the quality scale used needs to be modified to better quantify the different levels of quality in apples.

Displays

Variables for the size of each display were created in the attempt to examine how quantity sold is impacted when an apple and pear variety have multiple displays. Variables were created for the sizes of a main display, a second display, and a third display. When the second and third display size variables were added to the model, there were not enough non-zero observations to warrant keeping the third display size variable in the model. The third display size estimated coefficient was insignificant, while the second display size estimated coefficient was significant. Examining the display size estimated coefficients for all display revealed that they were not significantly different from one another. Thus a single total display size variable appeared adequate and was used.

The outside display variable was a binary variable noting whether or not a specific product had a display outside of the produce department, including in front of the store. The outside displays variable was left out of the model because in the Gala, Red Delicious and Fuji equations the outside display variable was highly correlated with the store variables. Only Store 2 had significant non-zero observations of apple and pear varieties appearing outside of the produce area, because of this the outside display variable was highly correlated with the variable for Store 2.

Variations on the multiple display variables were used to determine how having multiple displays affects the share of expenditure levels. A variable was created to track when multiple displays were used in and out of the produce department. One multiple display variable included the outside displays where the other multiple display variable did not. The multiple display variables were insignificant in the model and excluded.

A freestanding display is a display that has four sides that are accessible by consumers. Freestanding displays are usually in the form of bins that are placed on the floor of the produce department. There were few non-zero observations for the freestanding variable, resulting in the freestanding display estimated coefficients being inconclusive. It was undetermined if freestanding display estimated coefficient was explaining the relevant information on the share of expenditures on fresh apples and pears.

Traffic Flow

Traffic Flow variables were created to determine how product placement in higher traffic flow areas would impact demand for apples and pears. The displays in the produce department were classified as high, medium and low traffic flow areas, from discussions with the produce department staff. High traffic flow areas were areas that see a high level of consumer traffic, medium traffic flow areas were areas that see a medium level of consumer traffic, and low traffic flow areas were areas that see little consumer traffic. Due to the fact that produce managers rarely change the placement of apples and pear displays, there was little variation in the traffic flow variables. This resulted in the estimated traffic flow coefficients in the Gala, Fuji and Red Delicious apple equations being insignificant; thus, they were excluded.

Entry

An entry variable was created to determine if a product placed in the entrance of the produce department would affect the share of expenditures on that product. Entry displays would be those displays that consumers would see first as they entered the produce department. The entry variable was insignificant across share equations. The entry variable was excluded from the model because there were to few non-zero observations for tart apples, Red Delicious, and Fuji apples.

A Second Small Sized Product Available

A binary variable was created to determine how the share of expenditures is affected by the availability of a smaller sized product. The PLU numbers that appeared on the individual products are different depending on the size of the product. If the large and small sized products appeared in the same display then the two sizes were treated as one product. The small sized product was not frequently available to consumers, resulting in the estimated coefficients being insignificant in the Gala, Red Delicious and Fuji share equations. So the second small sized product available variable was excluded from the model

In-Store Specials

The in-store special variable reflects specials that do not appear in the weekly flier. The wording in-store special would appear on the point-of-purchase signage for those products that were an in-store special for a given week. The in-store specials were unique to each store.

In-store specials were uncommon during the data collection process. There were only two non-zero observations for Gala apples and only six for Fuji apples. The in-store special coefficients were insignificant in the Fuji and Red Delicious share equations. For these reasons, the in-store special variables were excluded from the model.

Food Alliance

The Food Alliance is a non-profit organization that promotes sustainable agriculture. Producers can be certified as being Food Alliance approved, which allows the producers to use the Food Alliance label on their products. Food Alliance variables were created to track how the use of the Food Alliance label and Food Alliance signage influenced consumer behavior. If Food Alliance stickers appeared on a majority of a given fruit within a display then it was determined that the Food Alliance label was in use. The Food Alliance signage was measured and used to create a variable similar to the total point-of-purchase variable (i.e., the total surface area measured in square inches of the signage).

There were mixed results from the Food Alliance variables. The variable for the use of the Food Alliance label was significant and positive in some of the share equations but it was insignificant or significant and negative in other share equations. Similar results were found for the Food Alliance signage variable. Some of the variability in the results could be due to a quality issue. For those share equations that the Food Alliance variables were significant, it could be caused by changes in the product quality. The Food Alliance variables were excluded from the model because it was unclear if these variables were explaining how the use of the Food Alliance label or signage is affecting consumer-purchasing behaviors or if these variables are explaining changes in quality from Food Alliance approved products to those products that are not Food Alliance approved.

Lagged Variables

One period lagged variables of own-price and in-store advertisements were included in the model. The lagged variables of own-price and in-store advertisements were estimated in an attempt to observe how the previous weeks prices and in-store advertisements affect the share of expenditures for fresh apples and pears. The lagged variables for own-price and in-store advertisements were insignificant and reduced the significance levels of the current coefficients of own-price and in-store advertisement. Attempts to incorporate lagged values of the own-price and in-store advertisement variables resulted in insignificant coefficients so the lagged variables were excluded in the model.

Nutritional/Health Information

Nutritional variables were created based on the Five-a-Day ad promotion, nutritional facts inserts, and other informative material. The nutritional variables were not included in the model because the use of the Five-a-Day ad promotion and the other informative material only appeared in one store. The Five-a-Day ad promotion was not placed in accordance of any specific fruit variety. The Five-a-Day ad promotions were placed sporadically throughout the store to fill blank space. There were few non-zero observations of the other informative material. The nutritional facts inserts variable was highly correlated with the store variables. No nutritional variables were included in the model because of store correlation problems and few non-zero observations.

Incorrect Use of Inserts and Advertisements

Incorrect use of inserts and advertisements was occasionally observed in the stores and binary variables relating to incorrect usage were created. The variables included incorrect use of in-store special inserts, not using an advertisement insert when a product was advertised, when prices differed between the point-of-purchase signage and the advertisement, and the use of an advertisement insert when products were not advertised. There were few non-zero observations for any specific apple or pear varieties so the variables for the incorrect use of inserts and advertisements were excluded from the model.

Appendix B. Model Specification

A non-linear AIDS model was selected to model share equations for fresh apple and pear varieties. The share equations that were included in the non-linear AIDS model are Gala, Fuji, Red Delicious, Other Sweet Apples, Tart Apples, and Pears. The Other Sweet Apples, Tart Apples and Pears share equations are aggregated over those fruit varieties that fit into these specific groups. This section discusses how these specific apple and pear share equations were selected.

To determine which apple varieties to model, product availability was examined. The fresh apples varieties that were available all year were Gala, Red Delicious, Golden Delicious, Fuji and Granny Smith. After narrowing down the varieties that are available all year the percentage of total apple sales was examined. Golden Delicious was excluded because the percentage of total apple sales was just over five percent, which was four percentage points lower then the next. Table A.1 displays the percentage of total sales the apples varieties that were available all year combined for both stores.

Table B.1 Percentages of Total Apple Sales by Apple Varieties that Were Available Year Round.

Variety	Percentage
Fuji	0.3193
Red Delicious	0.1245
Gala	0.1160
Granny Smith	0.0942
Golden Delicious	0.0515

The first model included share equations for Gala, Red Delicious, Fuji, Granny Smith, aggregated other apples, aggregated fresh bananas, and aggregated fresh pears. These seven equations provided a problem in modeling consumers purchasing habits for fresh fruit. When Granny Smith apples were included there was an autocorrelation problem. Considering that the flavor of Granny Smith is tart, and it is primarily used for cooking it was determined that this variety could be grouped into the other apples equation.

When the Granny Smith apples were added to the other apples equation the autocorrelation problem was still present but was not as prevalent. Due to the fact that the other apples equation had lumped sweet and tart apples together it was determined to separate the two into two separate equations, one for other sweet apples and one for tart apples. Any apples that were described as being tart or tangy were included in the tart equation. Any apples that were described as sweet were included in the other sweet equation.[11]

However, autocorrelation was still a problem. Two possible solutions were examined. First the first differences model was calculated. The first-differences model is calculated by taking each observation and subtracting the first lagged observation multiplied by the first order autocorrelation coefficient. The process meant that the first observation in the data set would be lost due to the fact of the subtraction of the lagged observation. Second, the model was estimated using a complete set of fresh fruits.

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[11] The information on the characteristics of the different apple varieties was obtained from the http://www.bighorsecreekfarm.com/descriptions1.htm

The comparison of the first-differences model and the model that included all fruit revealed the same relative coefficients. Each model solved the autocorrelation problem. It was decided to use the complete system over the first-differences model because the complete system provided a better representation of the factors that affect consumer-purchasing behavior for fresh apples and pears.

The next problem was the banana equation. Bananas were just not being modeled correctly using the same specifications that were being used on apples and pears. Variables that were significant in the other equations were not in the banana equation. Due to the fact that aggregated bananas were not the focus of this study and that the results did not change significantly when bananas were included in the model and when they were not, bananas were aggregated into all other fruit.

Appendix C. Hicksian Elasticities

Price Variables	Equations						
	Gala	Fuji	Red Delicious	Sweet Apples	Tart Apples	Pears	Other Fruit
Gala	-1.88	0.42	0.34	0.22	0.03	-0.25	1.13
Fuji	0.19	-1.43	0.05	0.27	0.18	-0.03	0.76
Red Delicious	0.45	0.16	-1.88	0.23	0.19	-0.10	0.95
Sweet Apple	0.09	0.23	0.07	-1.46	0.03	0.22	0.84
Tart Apple	0.01	0.19	0.07	0.03	-1.42	0.13	1.00
Pear Price	-0.11	-0.03	-0.03	0.25	0.12	-1.15	0.95
Other Fruit	0.04	0.06	0.03	0.08	0.08	0.08	-0.36

Appendix D. Data Collection Sheet

Store:
Week:

PLU	Type of Pear	Price	Location	FA	Size	Display	POP	Br/Mrk/Dam	Brill/Mature
4408	Asian								
4409	Bartlett								
4413	Bosc								
4414	Comice								
4416	Anjou								
4417	Red Anjou								
	Organic Anjou								
	Organic Asian								
PLU	Type of Apple	Price	Location	FA	Size	Display	POP	Br/Mrk/Dam	Brill/Mature
3066	Cameo								
4015	Small Red Delicious								
4016	Large Red Delicious								
4017	Granny Smith								
4020	Large Golden Delicious								
4021	Small Golden Delicious								
4103	Braeburn								
4128	Pink Lady								
4131	Fuji								
4135	Gala								
4139	Small Granny Smith								
4147	Jonagold								
4154	McIntosh								
4162	Pippin								
94015	Organic Red Delicious								
94129	Organic Fuji								
94139	Organic Granny Smith								
94173	Organic Gala								
PLU	Type of Bananas	Price	Location	FA	Size	Display	POP	Br/Mrk/Dam	Brill/Mature
4011	Dole								
4229	Burro								
4234	Baby								
4235	Plantain								
4237	Red Banded								
94011	Organic Dole								
PLU	Type of Apple Bags	Price	Location	FA	Size	Display	POP	Br/Mrk/Dam	Brill/Mature
33383-00003	Red Delicious								
33383-00083	Golden Delicious								
33383-00155	Granny Smith								
33383-00471	Braeburn								
33383-00703	Fuji								
33383-00743	Gala								
33383-00903	Organic Red Delicious								

PLU	Type of Grape	Price	Location	FA	Size	Display	POP
4022	Green Seedless						
4023	Red Seedless						
4056	Black Seedless						
4059	Black Seedless						
4638	Black Seedless						
94022	Green Seedless						
94023	Red Seedless						
PLU	Type of Orange	Price	Location	FA	Size	Display	POP
3107	Navel						
3108	Valencia						
4388	Sunkist						
93108	Valencia						
PLU	Type of Nectarine	Price	Location	FA	Size	Display	POP
3035	White						
4036	Nectarine						
4378	Nectarine						
94036	Nectarine						
94378	Nectarine						
PLU	Type of Peach	Price	Location	FA	Size	Display	POP
3113	Jupiter						
4038	Peach						
4044	Peach						
4401	White						
94044	Peach						
PLU	Type of Plum	Price	Location	FA	Size	Display	POP
4040	Black						
4042	Red						
4436	Italian Prune						
PLU	Type of Mangoes	Price	Location	FA	Size	Display	POP
4051	Mangoes						
4311	Mangoes						
4394	Mangoes						
94015	Mangoes						
PLU	Type of Kiwi	Price	Location	FA	Size	Display	POP
3279	Gold						
4030	Kiwi						
94030	Kiwi						
PLU	Type of Apricot	Price	Location	FA	Size	Display	POP
4218	Apricot						

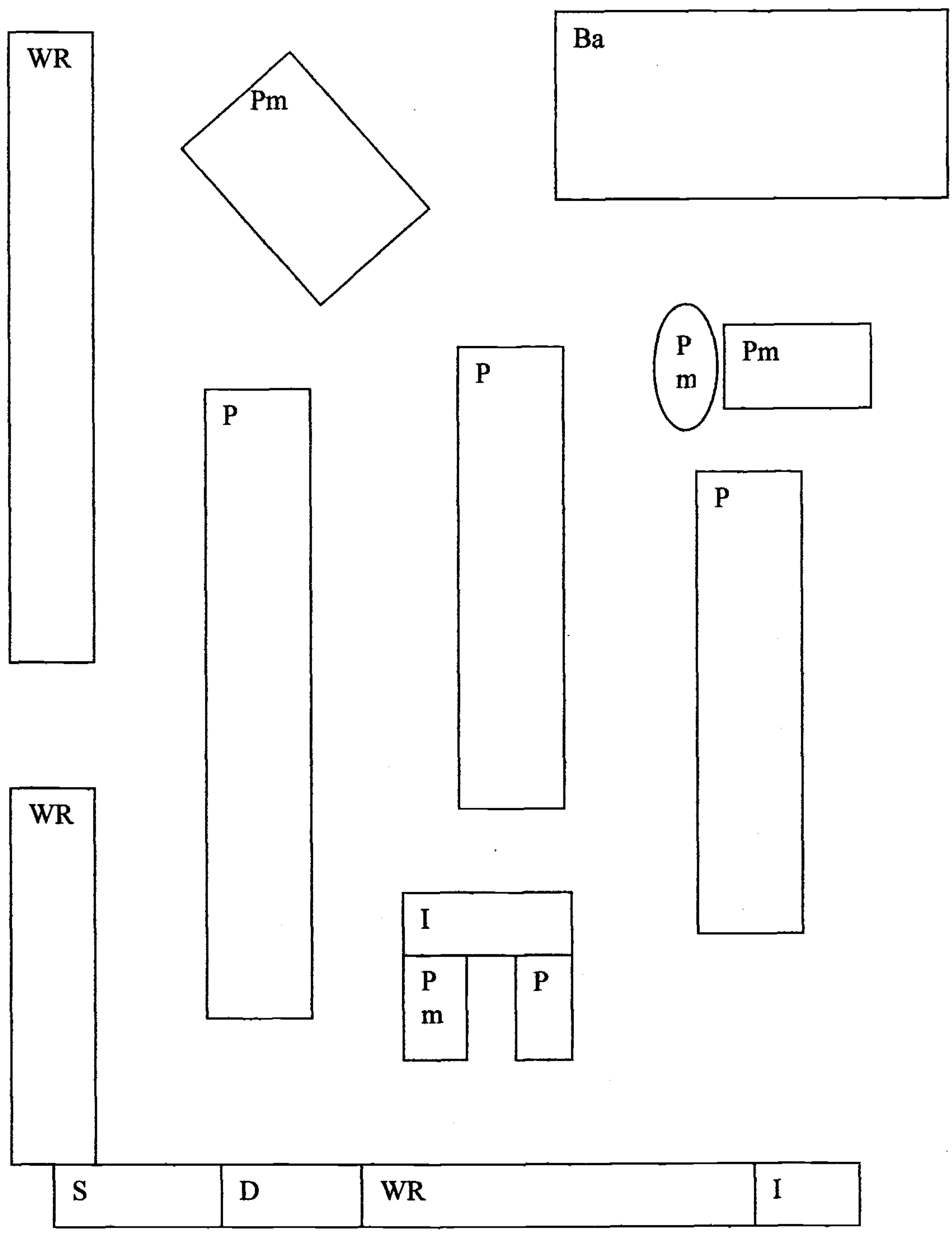
Appendix E. Produce Department Maps

List of Abbreviations for Produce Department Maps

Bakery	Ba
Bagged Salad Display	S
Candy Display	C
Cold Case	CC
Iced Display	I
Juice Display	J
Produce Bin	Pb
Produce Display	P
Produce Moveable Display	Pm
Salad Dressing Display	D
Wet Rack	WR

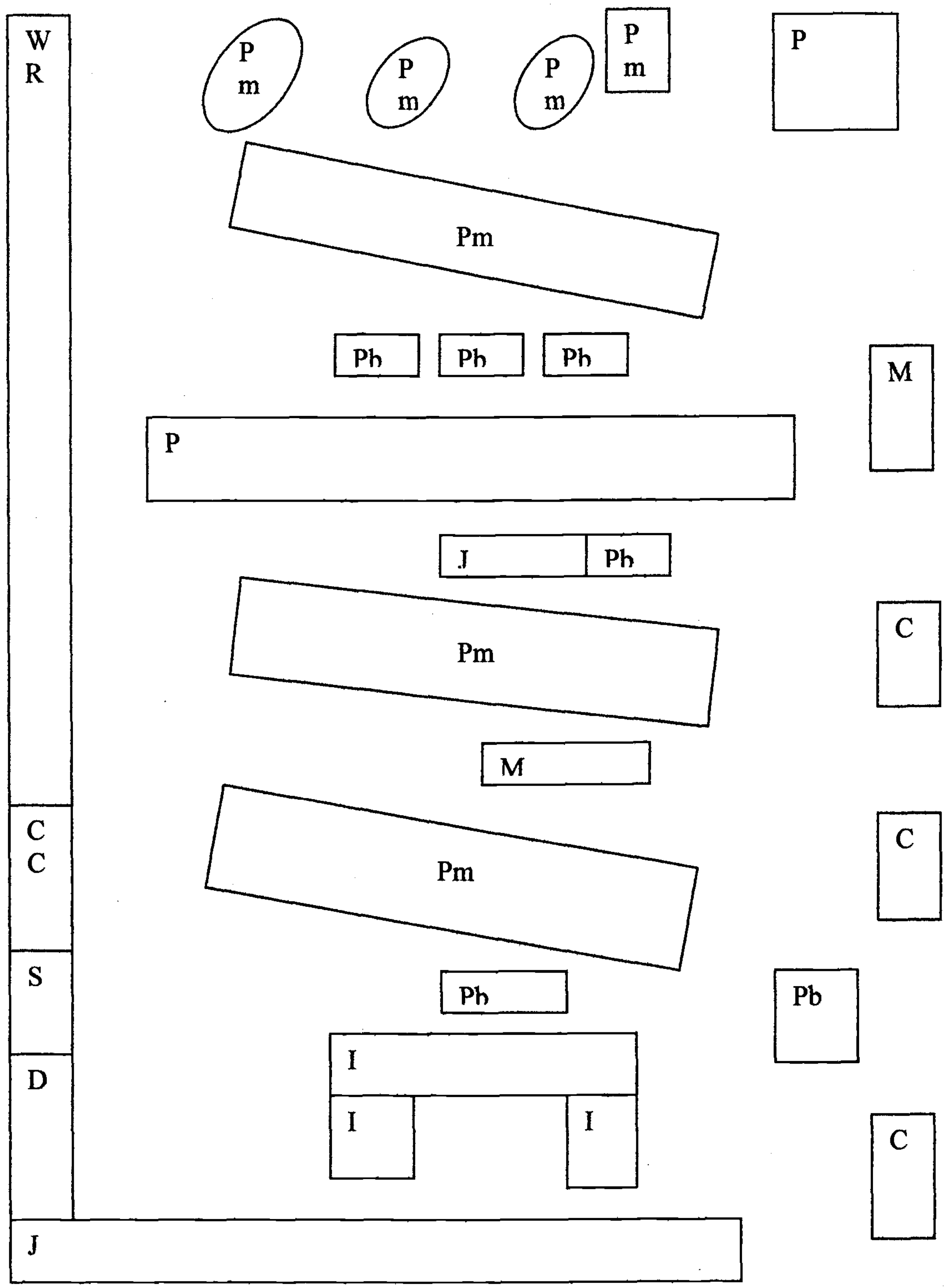
Store 1
Produce Area

Front of Store



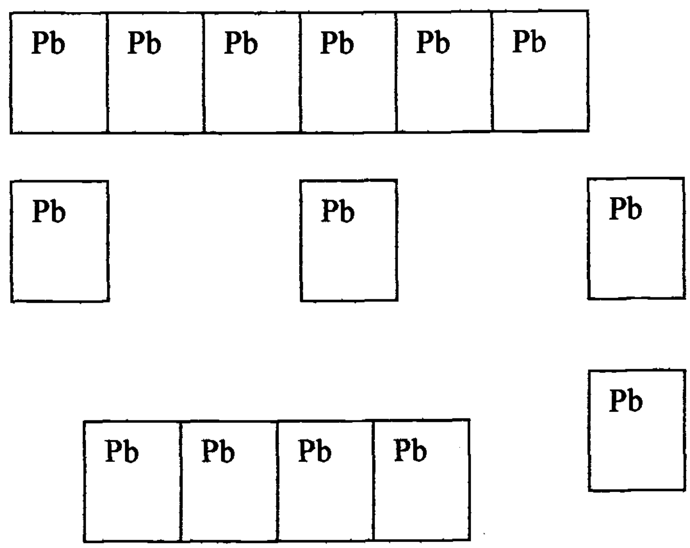
Store 2
Inside Produce Area

Front of Store



Store 2
Outside Produce Area

Parking Lot



Appendix F. Quality Measurement

Bruising

Definition: Any noticeable discolorations from improper handling

Ratings

Good: Rating 4
- Characteristics
  - Less then 10 % of the fruit on display has bruising

Above Average: Rating 3
- Characteristics
  - 10 to 30 % of the fruit on display has bruising

Average: Rating 2
- Characteristics
  - 30 to 50 % of the fruit on display has bruising

Below Average: Rating 1
- Characteristics
  - More than 50 % of the fruit on display has bruising

Development of the scale

- It is assumed that consumers are looking for fruit that visually appealing. An ideal fruit would not display any bruising, markings, or has not been damaged.

- The percentages were developed to get a quick assessment of the overall fruit display quality. A uniform set of percentages was developed to create easy use. It is assumed that the produce managers will not let their displays have more than 30 % of the produce exhibiting flaws at any one time. Therefore 30 % is the lowest quality characteristic.

- The terminology for markings was developed from the article by Anthony A. Williams and Caroline S. Carter, the website http://www.ams.usda.gov/howtobuy/fruit.htm, and from the phone interviews with produce managers.

Marking

Definition: Fruit that is shriveled, russet, a lacy brownish blemish-type coating on top of the skin, insect markings, waxy build up, or any dirt left on the fruit.

Ratings

Good: Rating 4
- Characteristic
  - Less then 10 % of the fruit on display has markings.

Above Average: Rating 3
- Characteristic
  - 10 to 30 % of the fruit on display has markings.

Average: Rating 2
- Characteristic
  - 30 to 50 % of the fruit on display has markings.

Below Average: Rating 1
- Characteristic
  - More than 50 % of the fruit on display has markings

Development of the scale

- It is assumed that consumers are looking for fruit that visually appealing. An ideal fruit would not display any bruising, markings, or has not been damaged.

- The percentages were developed to get a quick assessment of the overall fruit display quality. A uniform set of percentages was developed to create easy use. It is assumed that the produce managers will not let their displays have more than 30 % of the produce exhibiting flaws at any one time. Therefore, 30 % is the lowest quality characteristic.

- The terminology for markings was developed from the article by Anthony A. Williams and Caroline S. Carter, the website http://www.ams.usda.gov/howtobuy/fruit.htm, and from the phone interviews with produce managers.

Damage

Definition: Any holes or cuts that penetrate the skin of the fruit

Ratings

Good: Rating 4
- Characteristic
  - Less then 10 % of the fruit on display is damaged.

Above Average: Rating 3
- Characteristic
  - 10 to 30 % of the fruit on display is damaged

Average: Rating 2
- Characteristic
  - 30 to 50 % of the fruit on display is damaged

Below Average: Rating 1
- Characteristic
  - More than 50 % of the fruit on display is damaged

Development of the scale

- It is assumed that consumers are looking for fruit that visually appealing. An ideal fruit would not display any bruising, markings, or has not been damaged.

- The percentages were developed to get a quick assessment of the overall fruit display quality. A uniform set of percentages was developed to create easy use. It is assumed that the produce managers will not let their displays have more than 30 % of the produce exhibiting flaws at any one time. Therefore, 30 % is the lowest quality characteristic.

- The terminology for damage fruit came form the phone interviews with produce managers and from personal experience.

Brilliance

Definition: The appearance of how polished the fruit looks

Ratings

Good: Rating 4

- Characteristics
    - Brilliance of the fruit is very shiny

Above Average: Rating 3

- Characteristics
    - Brilliance of the fruit is shiny,

Average: Rating 2

- Characteristics
    - Brilliance of the fruit is glossy, which is half way between shiny and dull

Below Average: Rating 1

- Characteristics
    - Brilliance of the fruit is dull

Development of the scale

- It is assuming that consumers are looking for fruit that they will be able to take home, and enjoy at a later time. Desirable fruit would be nearly ripe or will ripen within a few days. Ideally, fruit characteristics would be shiny, have a bright correct color, and free of discolorations.

- The rating will be determined by brilliance of the fruit and then using the characteristic that is associated with the fruit either being immature or over ripe. A fruit cannot be both immature and over ripe so the second and third characteristic will not be used on each fruit.

- Terminology for brilliance was gathered from the article by Anthony A. Williams and Caroline S. Carter

- The percentages were developed to get a quick assessment of the overall quality. A uniform set for the percentage was used. It is assumed that the produce managers in each of their store will not let their display have more than 30 % of the produce exhibiting flaws at any one time. Therefore, 30 % is the lowest quality characteristic.

Fruit Maturity

Definition: Any flaw in color that is not associated with bruising, marking or damage. Color refers to flush, which should reflect a red, brown, or mixed color to signify ripeness

Ratings

Good: Rating 4

- Characteristics
  - The ground color is yellow/red/brown/green, depending on variety, 0 to 10% degree of the ground color being green/yellow. (Immature)
  - 0 to 10% of the fruit show discolorations (Over ripe)

Above Average: Rating 3

- Characteristics
  - The ground color predominately yellow/red/brown/green, depending on variety, with 10 to 30% degree of the ground color being green/yellow. (Immature)
  - 10 to 30 % of the fruit show discolorations (Over ripe)

Average: Rating 2

- Characteristics
  - The ground color is predominately green/yellow (Immature) with 30 to 50% when ground color is yellow/red/brown/green, depending on variety
  - 30 to 50 % of the fruit show discolorations (Over ripe)

Below Average: Rating 1

- Characteristics
  - 50% of the fruit being green/yellow (Immature) when ground color is yellow/red/brown/green, depending on variety
  - 50% of the fruit show discolorations (Over ripe)

Development of the scale

- It is assumed that consumers are looking for fruit that they will be able to take home, and enjoy at a later time. Desirable fruit would be nearly ripe or will ripen within a few days. Ideally, fruit characteristics would be shiny, have a bright correct color, and free of discolorations.

- This scale has been developed to incorporate that fruit can be over and under ripe. If the ground color is green the fruit will be assumed to be under ripe, and as the amount of discolorations increase then the fruit will be assumed to be overripe. Some exceptions have been made for apples and pears. Information from the website http://www.ams.usda.gov/howtobuy/fruit.htm state that for Bartlett pears are pale yellow to rich yellow color, Anjou or Comice pears are light green to yellowish-green color, Bosc pears are greenish-yellow to brownish-yellow color, and Granny Smith apples have a green color, when the different fruits are mature.

- The terminology for discolorations was developed by using the description of flush from the article by Anthony A. Williams and Caroline S. Carter, by the website http://www.ams.usda.gov/howtobuy/fruit.htm, and from the phone interviews with produce managers.

- Discoloration has to be 25% or more on each individual fruit, or it will not be counted.

- The terminology for ground color came from the article by Anthony A. Williams and Caroline S. Carter.

- The percentages were developed to get a quick assessment of the overall quality. A uniform set for the percentage was used. It is assumed that the produce managers in each of their store will not let their display have more than 30 % of the produce exhibiting flaws at any one time. Therefore, 30 % is the lowest quality characteristic.