EVOLUTION OF THE INDUSTRY STRUCTURE OF THE DRIED PLUMS MARKET

by

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Abstract

The objective of this analysis is to derive several econometric estimates of the Panzar-Rosse statistic of industry structure in order to determine whether the dried plums market resembles that of a firm collusion (monopoly or tightly structured oligopoly), a hybrid of monopolistic and competitive tendencies (monopolistically competitive), or perfectly competitive. The result of the Panzar-Rosse test is the H-Statistic: the sum of all elasticities of a firm's total revenue with respect to factor prices focusing on the long run equilibrium.

This study looks at data from a previous study conducted by Alston et al (1998) that includes firm level data for three of the participating firms in the dried plums industry from September 6, 1992 through July 7, 1996 and data provided from Sunsweet Cooperative encompassing firm level data from six firm participants from July 20, 2008 through June 13, 2010. Ordinary least squares regression equations were estimated to determine the elasticities of firm level input costs and other exogenous variables. A total of four regression equations per data set were tested in order to compile the necessary information for the formulation of the Panzar-Rosse H-Statistic. Adjusting for econometric concerns, overall the results show an H-Statistic commensurate with that of an industry that is operating as monopolistically competitive. In examining the evolution of firm-level changes from the time period of the first data set to that of the second, the results suggest the industry, while remaining monopolistically competitive, has also become more competitive; a finding consistent with the decreased concentration noted in the industry over time.

Table of Contents

List of Figures

List of Tables

Acknowledgements

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Dedication

This thesis, and all of my graduate work, is dedicated to those who joined me along my journey both at home in Virginia, and abroad in Kansas. Specifically, I would like to dedicate this work to my grandmother, Gatewood Stoneman. Without her encouragement and model inspiration, I would not be where I am today.

Furthermore, I would like to dedicate this work to Scott Sink. Without his encouragement to always ask “why” and to work feverishly until the job is done, I would not have taken the leap to join the Kansas State community.

Chapter 1 - Introduction

Several tendencies in small, niche agricultural markets, such as the dried plums (prunes) market, suggest that the industry is behaving as a monopolistically competitive one. In this study, we examine the recent evolution of the industry structure of the dried plums market by looking at firm level data from several time periods. Through this examination, we focus specifically on retail input and output costs and price tendencies throughout the market. In doing so, we derive several econometric estimates of the Panzar-Rosse statistic of industry structure in order to determine whether the dried plums market resembles that of firm collusion (monopoly or tightly structured oligopoly), a hybrid of monopolistic and competitive tendencies (monopolistically competitive), or perfectly competitive. The following introduction is a background of the trends in the dried plum industry, the history of dried plum processing, and a review of economic definitions pertaining to industry structure.

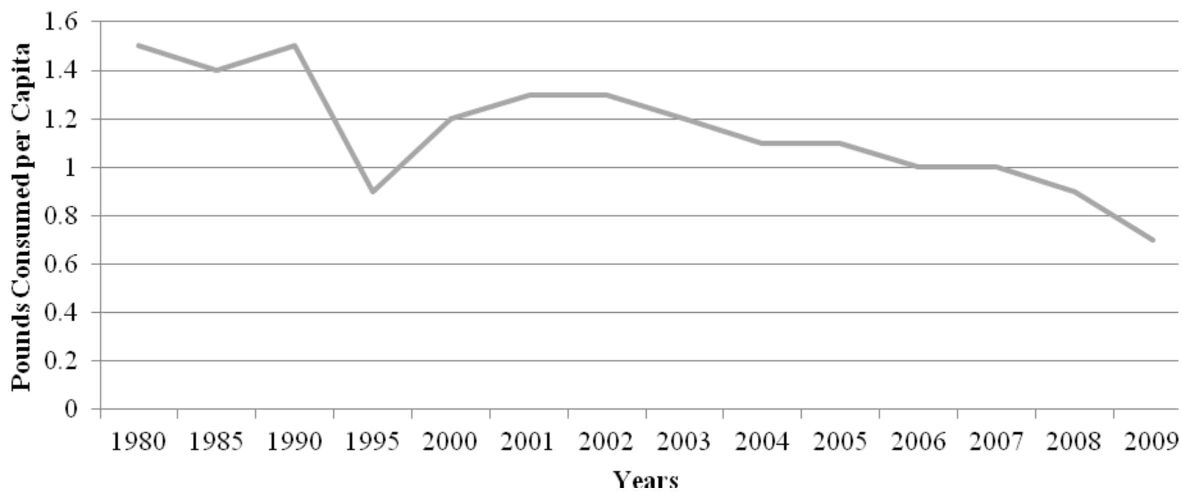
United States Dried Plum Production

Dried plum trees were first introduced to North America circa 1856 from France and were first transplanted in California and crossed with wild dried plum varieties that were already grown there. Previously, apples and pears were the largest commodity being grown in California, but with a drastic decline in the apple and pear market, more and more dried plum varieties were being planted all across California as a profit stabilizing measure. Dried plum demand increased steadily with this market shift and thus California became prime dried plum growing territory, producing over 70 percent of the world's entire dried plum crop.

Sunsweet Cooperative, the world's largest dried plum processor, began in the world's largest dried plum producing locality, Yuba County, California. Throughout the changing market atmosphere into the 1900's, Sunsweet worked steadily to advance sales of dried plums through advertising and marketing efforts. Currently there are several processors in California participating in similar efforts as discussed later in this introduction.

In the years leading up to 1980, there was an increase in the demand for added fiber in human diets, which included the consumption of dried plums. This large increase in demand led to a strong increase in producer returns that generally totaled over $1,000 per ton. With this increase in price came the predicable increase in the total acreage being planted for the production of dried plums. California dried plum producers increased their growing capacity from 70,000 acres to nearly 90,000 acres leading to production of over 200,000 tons of dried plum per year (Sunsweet Annual Report, 2009). Per-capita dried plum consumption has declined in recent years; however, as demonstrated in Figure 1.1 (USDA 2009), though the reasons are not entirely due to a decline in consumption.

Figure 1-1: Prune Consumption Trends Per Capita 1980-2009



The dried plum industry has dealt with a lot of fluctuation in dried plum consumption and thus, too the dollars paid to the producer in the past several years. Figure 1.2 shows the utilized production of dried plums from 1995 through 2009, and Figure 1.3 shows the dollars paid to producers from 1995 through 2009. These fluctuations have many causes, with the largest cause being a decline in export availability from the United States because of crop disasters in California. This then opened the market share for other dried plum exporters such of France, Chile, and Argentina. According to the USDA's Foreign Agriculture Service, Chile exports nearly 90 percent of its total dried plum production. Similar exports are seen out of Argentina as well. Currently, the United States and France export approximately 40 percent of their total dried plum production. The largest importer of dried plums from the United States is Japan (USDA FAS, 2005).

Figure 1-2:Utilized Dried Plum Production, 1995-2009

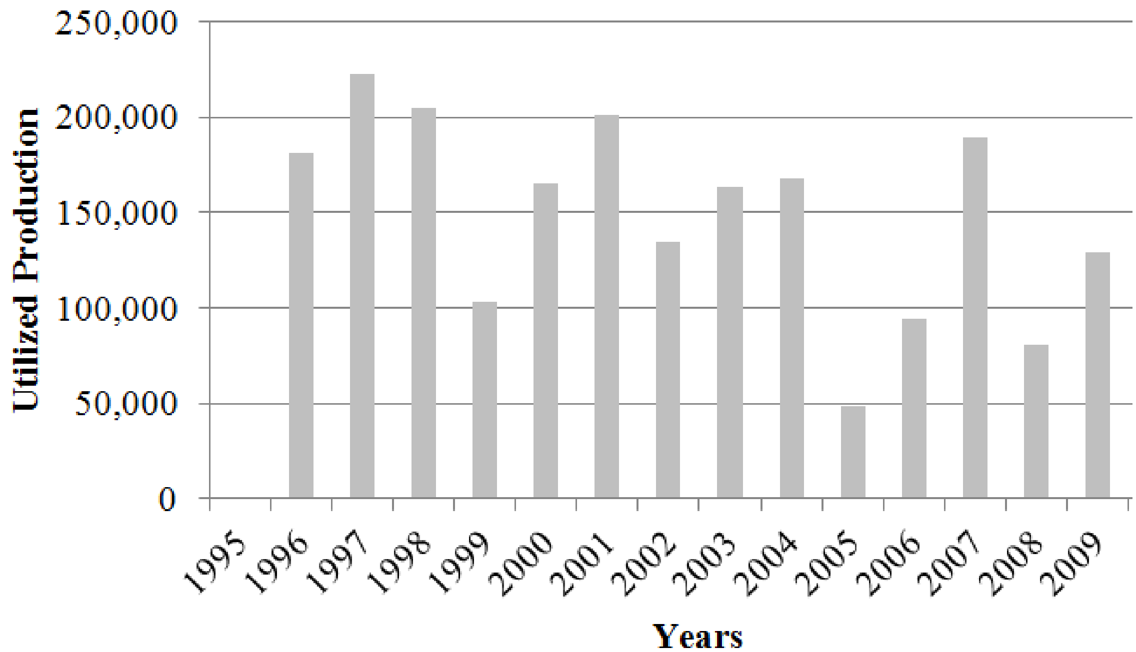
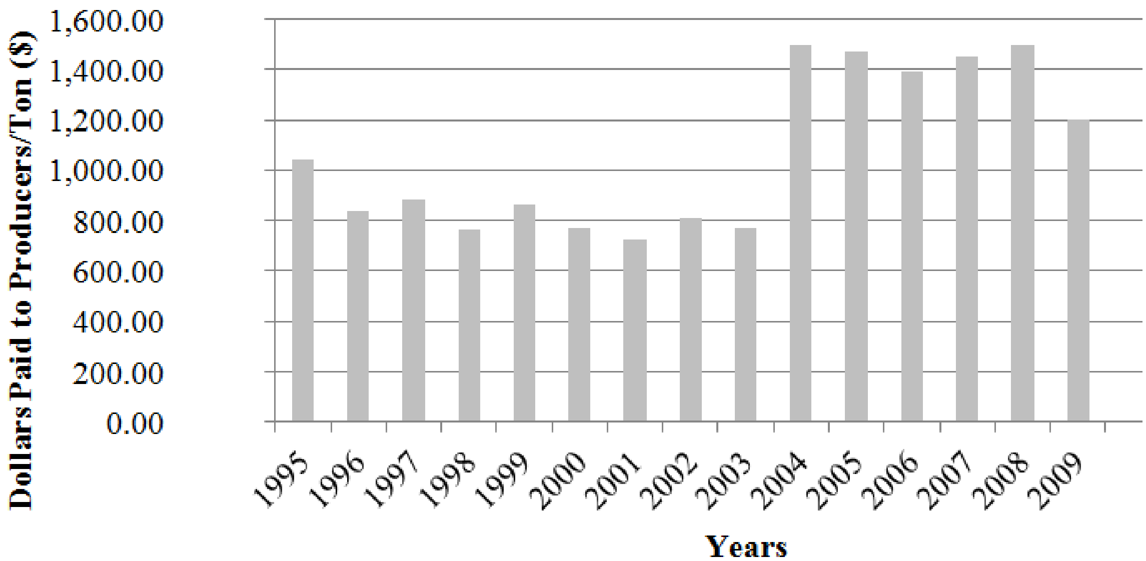


Figure 1-3:Dollars Paid to Producers, 1995-2009



Domestically, the decrease over the past 20 years in demand for dried plums is due in large part to marketing misconceptions. In 2001, the Food and Drug Administration approved the request to "re-identify prunes as dried plums after a request by the industry and the California Prune Board…in an attempt to overcome the negative perception of prunes being a laxative for the elderly" (Boriss et al 2011). More recently, processors such as Sunsweet, have been putting dried plums through the value-added process and producing such products as Sunsweet Ones®, individually wrapped dried plums that serve as a healthy and convenient snack. Processors have also increased the breadth of advertising to include such expenditures as having recipes that include dried plums as the focus in many home magazines.

Dried Plum Industry Chain and Processors

The dried plum marketing chain consists of growers, processors, and retailers. Processing begins when the fresh plum is mechanically harvested and then dehydrated shortly after harvest. The two most prevalent varieties are the "French Prune" and the "La Petite d'Agen". These varieties are popular because they have increased sweetness, which allows them to be dried without having to go through the fermentation process. "In 2008, one ton of dried prunes was equivalent to 2.9 tons of fresh prune variety plums" (Boriss et al 2011).

Over half of the dried plum producers in California belong to the Sunsweet Cooperative, the "industry's largest and only producer-owned processing/marketing cooperative for dried plums" (Boriss et al 2011). There are 20 other processors in operation in California, with seven processors handling the majority of the dried plum crop (California Dried Plum Board 2011). The competing processors examined in this study are Sunsweet, Private Label, Champion, Del Monte, Mariani, Sun Maid, and Dole.

Industry Structure Basics

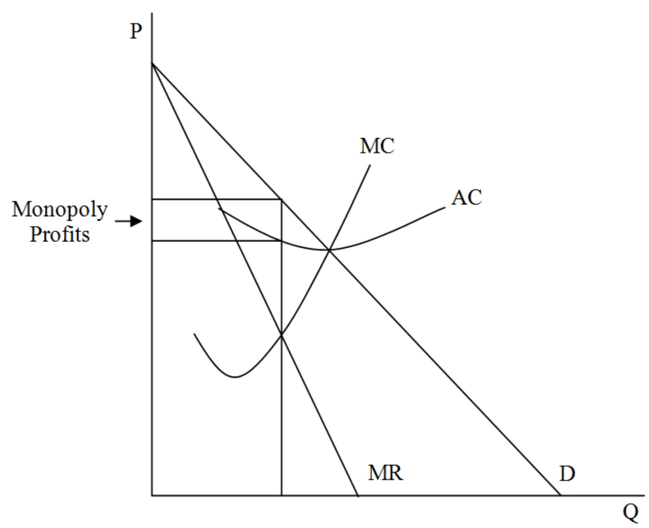
To examine the results of the models using the Panzar-Rosse test for industry structure, it is important to note a few key characteristics of monopolistic, monopolistically competitive, and perfectly competitive firms. The following descriptions adhere to general economic principles through definitions and graphical representations.

Monopoly

The widely accepted definition of a monopoly is a "single supplier to a market…[which] may choose to produce at any point on the market demand curve" (Nicholson 2008, p.491). The reason monopolies exist are typically due to significant barriers to entry that give a monopoly sole access to the market. Firms that act collusively also fit the characteristic of monopoly, this collusion is de jure illegal in the United States with the exception of particular collusive grants by the federal government. In order to maximize profits, all firms produce at an output level in which the marginal revenue is equal to marginal cost, but in the case of monopoly, marginal revenue does not usually equal price. Key characteristics of a monopolistic market are that the demand curve of a monopoly, being equivalent to the entire demand for the industry, is downward sloping. As marginal revenue decreases, quantity sold increases (Sanders 2009). Figure 1.4 shows the profit maximization of a monopoly, where *P* is price; *Q*, quantity; *MC*, marginal cost; *AC*, average cost; *MR*, marginal revenue; and *D*, demand (Sanders 2009).

Monopolies lead to the misallocation of resources because the price paid by the consumer exceeds the firm's marginal cost of production resulting in a deadweight loss to society and economic profits for the monopoly. Monopolies may also be able to increase profits in some circumstances by employing price discrimination if they are able to sell otherwise identical goods of output at varying prices (Nicholson 2008, p. 407).

Figure 1-4:Profit Maximization of a Monopoly

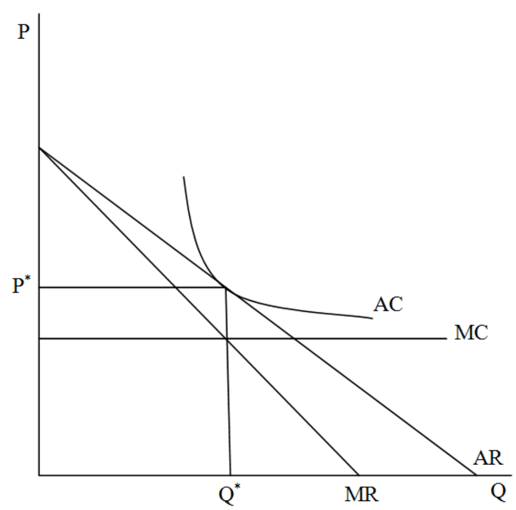


Monopolistic Competition

Monopolistic competition is defined as an industry structure that has many competitors, with a very slightly modified output among the firms. Monopolistic competition was first defined in the 1930s by Edward Chamberlin and Joan Robinson. Because of the importance to this thesis, a fuller discussion of monopolistic competition is presented in the literature review of Chapter 2. Common examples of firms believed to be operating under monopolistic competition include banks and restaurants. Key characteristics of monopolistic competition include the idea that under this industry structure, relative to the monopoly or oligopoly cases, there are lower barriers to entry, if any; knowledge of product processes is widely known, but is not perfect between firms; each firm makes its own selling decisions based on its own particular costs of production; oftentimes products are differentiated, but ever so slightly; firms are price makers facing a downward sloping, firm-level demand curve; while exhibiting monopolistic tendencies, advertising is a must, but can oftentimes be done as a whole industry; and they are assumed to be profit maximizers (Monopolistic Competition 2011).

Figure 1.5 demonstrates a typical marginal revenue and average cost curve for monopolistic competition. "In equilibrium, the firm is producing where average revenue (*AR*) is tangent to average costs (*AC*), also where marginal revenue (*MR*) is equal to marginal cost (*MC*) resulting in price being greater than marginal cost but equal to average cost for zero economic profit" (Silva 2010, p.22).

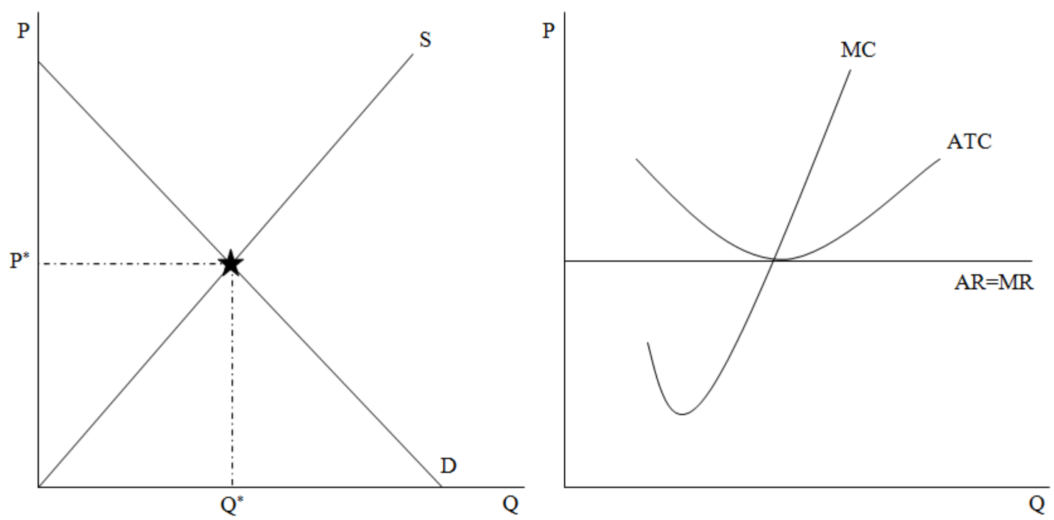
Figure 1-5:Monopolistic Competition



Perfect Competition

The typical discussion of perfect competition includes a description of an industry with many buyers and sellers; no barriers to entry; buyers and sellers having perfect information; and firms producing homogeneous goods. Perfectly competitive firms, like all firms, produce where marginal revenue equals marginal cost. However, in the case of perfect competition because the price is determined at the intersection of market supply (the horizontal sum of all firms' marginal cost curves) and market demand (the horizontal sum of all consumers' demand curves), the perfectly competitive firm has a marginal revenue equal to price. In other words, the firm is a price taker as opposed to the price makers of the previous two examples. Figure 1.6 shows the equilibrium of supply and demand under perfect competition and shows that perfectly competitive firms are both allocatively and productively efficient where price (*P*), equals marginal cost (*MC)*, and average total cost (*ATC*), equals marginal cost (*MC)*.

Figure 1-6:Equilibrium and Efficiency of Perfect Competition



Chapter 2 - Literature Review

Panzar-Rosse Test for Industry Structure

The model used in this thesis is an application of the Panzar-Rosse test for "monopoly equilibrium" (Panzar and Rosse 1987). This test was developed by John Panzar and James Rosse and results in a comparative statics analysis based on testable predications from the "firm's reduced form revenue equation" (Panzar and Rosse 1987, p. 443). The end result of this test is the Panzar-Rosse H-Statistic: the sum of all of the elasticities of a firm's total revenue with respect to factor input prices focusing on the long-run equilibrium. Although similar in function to the various statistical estimations of conjectural variations and other market power parameters, the Panzar-Rosse test is particularly useful because it includes monopolistic competition as one of the interpretations of the industry-structure parameter. This is important in industries for which a great deal of product differentiation is seen along with relatively low barriers to entry. The details of the construction of the H-Statistic are fairly complicated, but the parameter itself is straightforward after estimating a fixed-effects econometric model of firm-level revenue over time estimated as a reduced-form equation. As will be shown below, the dependent variable is the log of firm revenue and the independent variables consist of representative input costs and other exogenous variables. The H-Statistic itself is simply the sum of the coefficients on the logged values of the input values over all firms in the study. As explained by Goddard and Wilson (2006, p. 560) who applied the test to the U.S. banking industry, "H is negative if firms' pricing policies are consistent with the textbook model of monopoly. H is positive but less than unity under monopolistic competition, and H is unity under perfect competition." In simple terms, $H<0$ if an industry is monopolistic (e.g. firms are behaving collusively), $0<H<1$ if an industry is monopolistically competitive, and $H=1$ if the industry is perfectly competitive.

Studies Conducted Using the Panzar-Rosse Test

The majority of the studies conducted using the Panzar-Rosse test focus on the international trade and banking sectors. Hamza (2011, p.263) presented a summary of studies adopting the Panzar-Rosse test in the banking sector. The summarized research examined banking data collected from the United States, Canada, Japan, Germany, United Kingdom, France, Italy, Spain, Switzerland, Greece, New Zealand, Tunisia, Brazil, Hong Kong, and Korea and ranged in time from 1979 through 2006. A vast majority of the studies found that the retail banking industry is monopolistically competitive in the particular country being examined using the H-statistic.

In 1982, Shaffer authored the first reported application of the Panzar-Rosse test on the banking industry using an early draft of the work officially published by Panzar and Rosse in 1987 (Goddard and Wilson 2006). Based on his sample data of banks in New York, Shaffer found that the industry was monopolistically competitive. In 2006, Goddard and Wilson presented their findings after extrapolating data from 5,929 banks from 25 developed and developing countries.

Goddard and Wilson (2006) employed the Panzar-Rosse test through the fixed effects estimation of the following regression, using firm level-data:

$$\ln(r_{i,t}) = \delta_{0,i} + \sum_{j=1}^{J} \delta_j \ln(w_{j,i,t}) + \theta' x_{i,t} + \eta_{i,t}$$

In the above regression $r_{i,t}$ equals total revenue of bank i in year t; $w_{j,i,t}$ equals the price of the factor input j; $x_{i,t}$ is a vector of exogenous control variables; $\eta_{i,t}$ is a random disturbance term; and $\sum_{j=1}^{J} \delta_j$ is the H-Statistic (Goddard and Wilson 2006). While Goddard and Wilson found that the fixed effects estimator and the H-Statistic were significantly biased to zero, the "proportions of the countries for which [they] were unable to reject a null hypothesis of H=1 in favor of an alternative of H<1 turn out to be identical for the models based on [fixed effects] and [general method of moments] estimation" (Goddard and Wilson 2006, p.543). Therefore, their findings were consistent with previous literature studies; they concluded that the banking sector was monopolistically competitive.

Other industry structures that have been evaluated using the Panzar-Rosse test include the airlines and motor carrier industries in the United States. Fischer and Kamerschen (2003) used the Panzar-Rosse test to examine the market structure of selected airport-pairs originating from the Atlanta airport. The airline industry has seen a shift from strict regulation to less stringent regulation which now allows airlines to employ their own pricing strategies, have more control over their flight schedules, and allows firms to make their own market entry and exit decisions. Proponents of this shift cite the opportunities for increased performance standards due to the increase in competiveness between firms.

Fischer and Kamerschen created models for each separate airline carrier using a general method of moments approach. They employed "price and quantity data for outbound traffic, year dummies and their interaction term as instruments for inbound traffic, and inbound data as instruments for outbound data" (Fischer and Kamerschen 2003, p. 82). They found that the majority of the airport-pairs tested were monopolistically competitive according to the Panzar-Rosse test and continued their analysis by performing cross-sectional regressions. Their final conclusion was that while these airport-pairs proved to be monopolistically competitive, the increase in competiveness in the airline industry is in the best interest of the traveling public (Fischer and Kamerschen 2003).

Transportation economist Savage (2011) used the Panzar-Rosse test to evaluate the United States motor carrier industry. According to the Federal Highway Commission, the interstate trucking industry consists of approximately 260,000 firms with 5 percent of these firms producing 70 percent of the industry miles. With this statistic in mind, Savage hypothesized that the Panzar-Rosse test would show that the interstate trucking industry is perfectly competitive; however, because of the entrance of stronger, smaller firms into the industry. He examined 85 firms from 1982 through 1987. Through his testing he found that the interstate trucking industry cannot be modeled in the long-run equilibrium because of the constant disequilibrium created by market entrants, thus causing an inability to correctly use the Panzar-Rosse test except for to determine that the interstate trucking industry is at neither of the extremes; totally monopolistic nor totally perfectly competitive.

To the best of our knowledge the Panzar-Rosse test has never been applied to the food manufacturing sector.

Industry Structure: Monopolistic Competition

While the Panzar-Rosse test does concern monopolies, monopolistic competition, and perfect competition, an emphasis is placed on monopolistic competition in this thesis due to the hypothesis that the dried plum industry in the United States is monopolistically competitive. "Monopolistic competition occurs when a firm is acting partially as a monopoly in that it has market power over a differentiated product and partially as a perfectly competitive firm in that it is producing where marginal revenue is equal to marginal costs, but price equals average cost, or with zero economic profits in the long-run" (Silva 2010, p. 20). In a monopolistically competitive market, there are relatively low barriers to entry. Product differentiation creates a situation where firms in a monopolistically competitive industry face downward sloping demand curves.

Monopolistic competition was first presented by Chamberlin (1933) and Robinson (1933). Chamberlin (1933) was the first to coin the specific term “monopolistic competition”; however. As defined in Sullivan and Sheffrin (2001), monopolistic competition is a “market serviced by dozens of firms selling slightly different products.” Multiple firms are participating because there are relatively small economies of scale, which allow for larger and smaller firms to coexist at about the same level and industry structure, and both remain profitable due to product differentiation (Silva 2010, p.22).

Most of the literature on monopolistic competition simply confirms its existence and provides further basic definitions of the industry structure while also mentioning its effects on international trade. Some of these examples include “Krugman (1979), Lanclos and Hertel (1995), Heffernan (2002), Coto-Martinez (2006), Feenstra and Taylor (2008), Raun, Gopinath, and Buccola (2008) and Feenstra and Weinstein (2010)” (Boland et al 2012, p.4-5). Lanclos and Hertel (1995) specifically mention differences between perfect competition and monopolistic competition by examining the dependence of monopolistically competitive firms on fixed costs, which include farm and food input costs leading into the processing sector, thus monopolistic competition is more effected by price fluctuations of fixed costs. Fixed costs are absent under perfect competition; however, but because of this variability of costs, more market exits occur by firms that cannot keep up with the volatility of the market. Aside from these literary examples, there are very few that present models that test for monopolistic competition, and even fewer have any mention of the food and agricultural industry.

As shown by Silva (2010) in a previous study conducted at Kansas State University, the Sunsweet Cooperative has a downward sloping demand curve which demonstrates that the individual firm is consistent with a “monopoly” over its product range. Previously, a study conducted by Alston et al. (1998) found that the Sunsweet Cooperative, California’s largest member owned cooperative, controlled over 70 percent of the retail sales in the dried plums industry with their retail competitors at the time being primarily the firms Del Monte and Dole. Since this study was conducted, the number of competitors has increased, leading to a decline of Sunsweet’s market share to 58 percent suggesting that there were profits to be made in the industry, thus the increase of market entrants occurred. This increase in the number of firms participating in the industry led to the increase of product differentiation and indicates a potential shift from a tight structural oligopoly, or dominant firm model, to a model more consistent with monopolistic competition. Figure 2.1 demonstrates the movement of Sunsweet to a long-run equilibrium under monopolistic competition.

Figure 2-1:Monopolistic Competition in the Short and Long Run

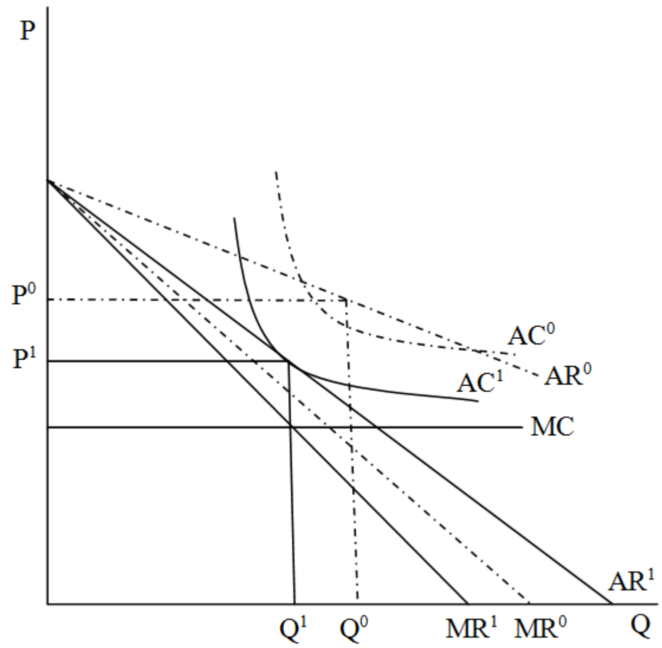


Figure 2.1 assumes that Sunsweet was initially producing on the portion of its average revenue curve where AR^0, average revenue, is greater than AC^0, average cost, as illustrated by the dashed lines. Because of this, other possible market entrants saw that there were profits to be made in the dried plum industry, and because barriers to entry are not high, entered into the market. Once more competitors entered into the market, Sunsweet saw a decrease in AR^1, average revenue, and thus their revenue shifted from AR^0 to AR^1 until average revenue was tangent to the new average cost curve, AC^1 as illustrated by the solid lines. Once this shift occurs, no new competitors will enter the market (Silva 2010, p.22). In the remaining chapters, we will show the evolution of the dried plum market's industry structure through showing the shift from a monopolistically leaning monopolistic competitor, to more of a perfect competition leaning monopolistic competitor.

Industry Structure of the United States Dried Plum Industry

According to Boland et al (2012) in their study of advertising benefits under monopolistic competition, the industry structure for dried and dehydrated foods has been able to escape the concentration ratios as seen by other participants in the food industry with a “four firm concentration ratio in 2007 of only 35.9%”. Because dried plum consumption has been declining during the past decade, there have been major shifts in the amount of production seen at the farm-level, thus leading to a decline of exports. Interestingly enough, even though there has been a decline in dried plum consumption, there has been an increase in the number of firm-level participants. During the 1990s, there were three firms that held a majority of the market share in the domestic market with Sunsweet Cooperative holding 80 percent of the market share alone. Today, there are six major competitors, dropping Sunsweet’s market share to 60 percent. According to Dixit and Stiglitz (1977), this decline in demand along with an increase in the variety of products produced in the dried plums industry are possible outcomes of a monopolistically competitive industry structure.

In looking specifically at advertising within the dried plums industry, the vast majority of all promotions are paid for by Sunsweet Cooperative and the other competitors use the free-rider effect as described by Alston et al. (2007) and forgo most of their advertising expenses because the dried plums industry is selling homogenous products. Because of this effect, advertising expenses are not a barrier to entry, thus providing further evidence that the dried plums industry is monopolistically competitive.

Even though firms use the free-rider effect in terms of advertising expenses, the varying dried plum brands are still clearly differentiated. This is evidenced by the variance in retail prices of dried plums and their differentiated product line (i.e. Sunsweet Ones ®). The variation of products by just a few firms is another key assumption of monopolistic competition (Boland et al 2012).

Chapter 3 - Data

The data set used for this study is weekly data ranging from September 6, 1992 through July 7, 1996 with a total of 52 observations per firm; and weekly data ranging July 20, 2008 through June 13, 2010 with a total of 100 observations per firm. The majority of the first data range, 1992 through 1996, was used in a previous study conducted by Alston et al. (1998), and was provided by the authors. The majority of the second data range, 2008 through 2010, was provided by the Sunsweet Cooperative. The following are the descriptions of the data used in the model described in Chapter 2, Literature Review.

Revenue

Revenue, *R*, is compiled by multiplying the branded quantity, the total number of prunes consumed in the United States for a specified week, by each brand's respective price. The quantities were broken down by firm: *QSUN*, *QPL*, *QCA*, *QDM*, *QMA*, *QSM*, and *QD* representing Sunsweet, Private Label, Champion, Del Monte, Mariani, Sun Maid, and Dole respectively. The price variables follow the same format: *PSUN*, *PPL*, *PCA*, *PDM*, *PMA*, *PSM*, and *PD*. *PSUN* represents the average price per pound of Sunsweet dried plums. This is the weighted average of the average promoted price per pound and the non-promoted price per pound for that particular week reflecting price discounts given at the retail level. These prices were provided by Sunsweet's Infoscan IRI database and were converted to 2010 dollars by using the Consumer Price Index, *CPI*, from the Bureau of Labor Statistics. These data were then multiplied by an average markdown percentage of 59 percent, an estimate provided by a Sunsweet analyst, to convert retail prices to Sunsweet's estimate of its perceived price (Silva 2010). While the average markdown is specified for Sunsweet, it is applied to all prices, Sunsweet and its competitors, for consistency.

PPL, *PCA*, *PDM*, *PMA*, *PSM*, and *PD* are the individual retail prices of each of Sunsweet's competitors. These prices were extracted from the Sunsweet Infoscan IRI database. All variables represent the average price per pound of prunes. This average consists of the average price per pound and the average non-promoted price per pound for that particular week weighted by the share of sales during these weeks. These prices were also converted to 2010 dollars using the *CPI*.

Marketing Costs

Promotion expenditure variables are the percentage of all commodity value of retail stores, and measure the trade merchandising "reach" and depth" of support; percentage of stores (in terms of annual sales) that sold the product with any sort of merchandising (features, displays, or price reductions) during a specified time period. As described by Crespi and Marette (2002), these variables are "weighted by store size that show whether a particular promotion was occurring in a store at time, t". Promotion expenditure variables are broken down by display, *%ACVD*; feature, *%ACVF*; and feature/display, *%ACVFD*. A display is a promotion using an in-store display with no other advertising occurring in-store. A feature is a product promotion without a display, such as newspaper advertising. A feature and display is a combination of both of these methods. Since the price of these expenditures is already reflected in price promotions, we need not include price promotions as a part of *%ACVD*, *%ACVF*, and *%ACVFD*. These variables are essentially proxy firm expenditures and can be best thought of as representing 'promotions' instead of advertising (Silva 2010). Our assumption is that the promotion expenditures correlate perfectly over the short time period with the actual percentage variables. For example, if x is a unit of promotion, and w is the cost of that promotion, then the percentage change in $w*x$ is equal to the percentage change captured by *%ACVD*, *%ACVF*, and *%ACVFD*. To the extent that this assertion is incorrect, we leave that as a caveat of the analysis as it was not clear how to test this assertion. Nonetheless, expenditure increases with increased promotion seems reasonable.

Also included in the model are the expenditures for Sunsweet Cooperative's television promotions, *SunTV*. These expenditures are in dollars and are weighted to account for the varying times the commercials are displayed during broadcast. The other firms did not conduct national television advertising during the time periods of either of the data sets.

FarmP is the annual value per unit (ton) price of California dried plums according the United States Department of Agriculture (2011). *FarmP* is the average annual farm price based on the date in which the data was collected spanning from 1992 through 1996 and from 2008 through 2010. This value was used to estimate the cost of the dried plums to the firm. It must be noted that *FarmP* has little variance over the time periods in both data sets.

Other Revenue Shifters

We included other shifters that may have effects on the branded revenues. The Producer Price Index, *PPI*, is included in this model to help account for the average changes in price faced by the producer. The *PPI* is also compiled on an annual basis and was assigned in accordance to the above criteria.

Quarterly data of per-capita personal income (*Income*) extracted from the Bureau of Labor Statistics is used in this model. Income was also adjusted to 2010 dollars using *CPI*.

Dried plum substitutes prices (*RPS*) include the prices of pertinent substitutes for dried plums, specifically other dried fruits and raisins. This variable was also multiplied by the aforementioned 59 percent markdown to convert retail prices to processor prices.

SUD, *PLD*, *CAD*, *DMD*, *MAD*, *SMD*, and *DD* are firm dummy variables to represent the firms Sunsweet, Private Label, Champion, Del Monte, Mariani, Sun Maid, and Dole respectively. Including these creates a fixed-effects regression model.

A time trend variable was added to the model and was simply a numbering of each observation from 1 to 53 for the early years' data set and 1 to 100 for the more recent years' data set.

On the following pages, Table 3.1 provides a detailed listing of the variables used, followed by Table 3.2 which shows the summary statistics for the data.

Table 3-1:Variable Descriptions

Variable	Definition	Units	Data Source
QSUN, *QPL*, *QCA*, *QDM*, *QMA*, *QSM*, and *QD*	Weekly volume of sales by firm	Pounds	Sunsweet Infoscan IRI Database
PSUN, *PPL*, *PCA*, *PDM*, *PMA*, *PSM*, and *PD*	Average retail price of dried plums from firm to retailers	Real dollars (2010) per pound of dried plums	Retail prices came from Infoscan IRI data provided by Sunsweet, were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
R	Total weekly volume of sales by firm multiplied by the average retail price of dried plums from firm to retailers for all firms	Real dollars (2010)	Retail prices came from Infoscan IRI data provided by Sunsweet, were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
CPI	Consumer Price Index, Average change in the price that consumers pay for goods	Percentage	Bureau of Labor Statistics
%ACVD	Percentage of all commodity value of retail stores with a display	Percentage	Sunsweet Infoscan IRI Database
%ACVF	Percentage of all commodity value of retail stores with a feature	Percentage	Sunsweet Infoscan IRI Database

Continued.

Variable	Definition	Units	Data Source
%ACVFD	Percentage of all commodity value of retail stores with a feature and display	Percentage	Sunsweet Infoscan IRI Database
SunTV	Weighted expenditures of Sunsweet television promotions	Real dollars (2010)	Sunsweet Infoscan IRI Database
FarmP	Value per ton of dried plums to the producer	Real dollars (2010)	United States Department of Agriculture
PPI	Producer Price Index, Average change in the price faced by producers	Percentage	Bureau of Labor Statistics
Income	Yearly average personal income	Personal income by quarter in real dollars (2010)	Bureau of Economic Analysis; Adjusted by CPI
RPS	Average price of substitutes for dried plums	Real dollars (2010)	Retail prices came from Infoscan IRI data provided by Sunsweet, were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
SUD, *PLD*, *CAD*, *DMD*,*MAD*,*SMD*, and *DD*	Dummy variables representing each firm respectively		
Trend	Time Trend	1,2,3…	

Table 3-2:Summary Statistics: 1992-1996

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Revenue (Monthly)	156	1,158,649	1,164,546	71,093.99	2,914,738
Revenue (~Weekly)	156	289,662.25	291,136.5	17,773.50	728,684.5
%ACVD	156	4.661257	5.11859	0	18.001
%ACVF	156	7.712538	8.888564	0	30
%ACVFD	156	1.379205	1.958745	0	8
SUNTV	156	111,098.3	175,529.5	0	565,361.4
FarmP	156	1,102.059	121.7221	839	1,234.84
PPI	156	129.3096	3.455277	125.8	134.6
CPI	156	0.9470385	0.0300715	0.896	1
Income	156	18,706.49	503.6629	17,780.13	19,500
RPS	156	2.393279	0.0412976	2.308167	2.524745
Trend	156	26.5	15.056647	1	52

Note: Original *Revenue* data was provided on a per month basis for this particular data set. It was converted to a '~Weekly' basis by dividing by four to account for the average four week month.

Table 3-3:Summary Statistics: 2008-2010

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Revenue (Weekly)	600	209,487.2	287,719.6	4,853.304	1,069,721
%ACVD	600	4.167613	2.990138	0.001	9.67603
%ACVF	600	0.5450405	0.9938818	0.001	7.38749
%ACVFD	600	0.1158278	0.2451074	0.001	2.08729
SUNTV	600	39,959.7	132,728.7	0.001	592,500.8
FarmP	600	1,306.979	116.5972	1,226.376	1,552.137
PPI	600	141.259	8.891322	131.2	162
CPI	600	0.9907537	.0115144	0.9664093	1.011165
Income	600	35,580.98	259.4966	35,124	35,920
RPS	600	0.3571155	.7996054	0.001	2.26457
Trend	600	50.5	28.89016	1	100

Chapter 4 - Regression Results

In this section, different regression equations are presented that will give us the results needed to calculate the Panzar-Rosse H-Statistic (as seen following these results in Chapter 5). Please note that several regression equations were tested, but we found that the four presented were a good representative sample of all models tested. Each of the Models 1 through 4 are the same for both sets of data, 1992 through 1996, and 2008 through 2010. Each data set has its own particular results provided following the presentation of the models.

Models

Model 1

$$\ln(R_{i,t}) = \delta_i + \delta_1 \ln(\%ACVD_{i,t}) + \delta_2 \ln(\%ACVF_{i,t}) + \delta_3 \ln(\%ACVFD_{i,t}) + \delta_4 \ln(SunTV_{i,t}) + \delta_5 \ln(FarmP_{i,t}) + \theta_1(RPS_t) + \theta_2(Income_t) + \theta_3 \ln(PPI_t) + \theta_4(Trend_t)$$

where $R_{i,t}$ is equal to the revenue of the firm, *i*, at time, *t*; δ_i represents the firm-level dummy variables with the excluded variable (the constant) representing Sunsweet (hence, *DMD*, *DD* for 1992 through 1996; and *PLD*, *CAD*, *DMD*, *MAD*, and *SMD* for 2008 through 2010); $\delta_1\ln(\%ACVD_{i,t})$, $\delta_2\ln(\%ACVF_{i,t})$, $\delta_3\ln(\%ACVFD_{i,t})$, $\delta_4\ln(SunTV_{i,t})$, and $\delta_5\ln(FarmP_{i,t})$ are the representative input costs for the industry based on the mean of firm level costs; $\theta_1(RPS_t)$, $\theta_2(Income_t)$, and $\theta_3\ln(PPI_t)$ are the representative exogenous variables affecting the industry; and $\theta_4(Trend_t)$ is a time trend variable applied to each observation. Other input costs that we would have liked to have included in our model but did not have access to include: processing costs, labor costs, manufacturing costs, and other input costs that are incurred by the firm.

Model 2

$$\ln(R_{i,t}) = \delta_i + \delta_1 \ln(\%ACVD_{i,t}) + \delta_2 \ln(\%ACVF_{i,t}) + \delta_3 \ln(\%ACVFD_{i,t}) + \delta_4 \ln(SunTV_{i,t}) + \theta_1(RPS_t) + \theta_2(Income_t) + \theta_3 \ln(PPI_t) + \theta_4(Trend_t)$$

The variable definitions are the same as with Model 1, but note that *FarmP* is excluded from this model.

Model 3

$$\ln(R_{i,t}) = \delta_i + \delta_1\ln(\%ACVD_{i,t}) + \delta_2\ln(\%ACVF_{i,t}) + \delta_3\ln(\%ACVFD_{i,t}) + \delta_4\ln(SunTV_{i,t}) + \delta_5\ln(FarmP_{i,t}) + \theta_1(RPS_t) + \theta_2(Income_t) + \theta_3(CPI_t) + \theta_4(Trend_t)$$

The variable definition are the same as with Model 1, but notice the inclusion of *CPI* and the exclusion of ln(*PPI*). The *CPI* did not need to be in the logged because there was weekly data available; therefore, providing enough variation so that it was not treated as a trend variable.

Model 4

$$\ln(R_{i,t}) = \delta_i + \delta_1\ln(\%ACVD_{i,t}) + \delta_2\ln(\%ACVF_{i,t}) + \delta_3\ln(\%ACVFD_{i,t}) + \delta_4\ln(SunTV_{i,t}) + \delta_5\ln(FarmP_{i,t}) + \theta_1(RPS_t) + \theta_2(Income_t) + \theta_3(CPI_t) + \theta_4\ln(Trend_t)$$

The variable names are the same with Model 3, but the *Trend* variable is logged in this model.

The following pages show regression results from each of the four models for each time period; 1992 through 1996, and 2008 through 2010. Following the results for each particular data set is further discussion about the findings. Under each model column, the tables show first the coefficient estimate, then the standard error in parentheses followed by the T-statistic in brackets.

Regression Results and Discussion: 1992-1996

Table 4-1:Regression Results: 1992-1996

Variable	Model 1	Model 2	Model 3	Model 4
ln(%ACVD)	.0432792 (.0061105) [7.08]*	.0432626 (.0060479) [7.15]*	0.0430762 (.0062266) [6.92]*	.0420032 (.0061911) [6.78]*
ln(%ACVF)	.0263363 (.0056917) [4.63]*	.0263239 (.0056473) [4.66]*	.0266292 (.0056715) [4.70]*	.0259467 (.0056786) [4.57]*
ln(%ACVFD)	.0231472 (.0064135) [3.61]*	.0231663 (.0063391) [3.65]*	.0230595 (.0064448) [3.58]*	.0226672 (.0064609) [3.51]*
ln(SunTV)	-.0171845 (.0317415) [-0.54]	-.0172009 (.0316242) [-0.54]	-.0152235 (.0320681) [-0.47]	-.0258522 (.0325546) [-0.79]
ln(FarmP)	-.0047654 (.2043228) [-0.02]	-	-.0045283 (.2103446) [-0.02]	-.4292513 (.2813841) [-1.53]
ln(PPI)	-.6256844 (1.151461) [-0.54]	-.626593 (1.146829) [-0.55]	-	-
CPI	-	-	.7954584 (9.881764) [0.08]	-11.04562 (7.355961) [-1.50]
Income	.0002723 (.0001686) [1.62]	.000274 (.0001511) [1.81]	.0002254 (.0002118) [1.06]	.0001702 (.0002126) [0.80]
RPS	.3835228 (.3346361) [1.15]	.3855786 (.3217033) [1.20]	.3540327 (.350203) [1.01]	.0781178 (.3112477) [0.25]
Trend	-.0218927 (.010595) [-2.07]*	-.0219809 (.0098625) [-2.23]*	-.0212207 (.0139907) [-1.52]	-
ln(Trend)	-	-	-	.0665861 (.0470981 [1.41]
PLD	-	-	-	-
CAD	-	-	-	-
DMD	-1.702067 (.6207804) [-2.74]*	-1.702333 (.6185327) [-2.75]*	-1.664212 (.6286356) [-2.65]*	-1.879201 (.6385181) [-2.94]*
MAD	-	-	-	-

Continued.

Variable	Model 1	Model 2	Model 3	Model 4
SMD	-	-	-	-
DD	-2.610841 (.6209821) [-4.20]*	-2.611151 (.6186964) [-4.22]*	-2.572776 (.6291) [-4.09]*	-2.790234 (.6389625) [-4.37]*
Constant	12.75399 (5.713159) [2.23]*	12.69228 (5.046174) [2.52]*	9.816055 (8.179948) [1.20]	25.01876 (4.732919) [5.29]*
Adjusted R^2	**0.9836**	**0.9837**	**0.9835**	**0.9835**

** Indicates statistically significant at 95% Confidence Interval*

Model 1 Results Discussion

Panzar and Rosse showed that the impact on most costs and *Revenue* are not necessarily obvious. Under different market structures the relationship might be positive or negative. In examining Model 1, we see that advertising display (*ln(%ACVD)*), advertising feature (*ln (%ACVF)*), and the combination of advertising display and feature (*ln(%ACVFD)*) all have a positive effect on revenue and are all statistically significant at the 95 percent confidence interval. This is to be expected because the purpose of advertising and promotions is to increase revenue. With a one-percent increase in advertising display expenditures, there is an expected 0.043 percent increase in revenue. With a one-percent increase in advertising feature expenditures, there is an expected 0.026 increase in revenue. With a one percent increase in a combination of both display and feature advertising, there is an expected 0.23 increase in revenue.

Sunsweet's TV advertising cost was found to have a negative effect on revenue. At first this might be surprising. However, we must recall that this is not a regression of Sunsweet's advertising on Sunsweet alone, but on all firms in the industry. Hence, while Sunsweet's TV advertising is expected to positively impact Sunsweet (as shown by Alston et al (1998) and Silva (2010)), it likely has a negative impact on the revenues of Sunsweet's competitors and on average the result on industry profits may be negative. However, the negative effect on revenue is quite small at -0.017, and the correlation results are insignificant at the 95 percent confidence interval so it is inconclusive as to whether these effects are telling or not. Farm price also had a negative effect on revenue, -0.004. This was also insignificant on the 95 percent confidence interval, so it is also inconclusive as to whether or not this is variable contains much information.

Because the farm price information was provided on a monthly basis, there was little variation in the data and this may be why we saw the insignificance.

In looking at the other revenue shifters in the regression, we see that *PPI* also has a negative effect on revenue and its coefficient is insignificant on the 95 percent confidence interval. Because *PPI* is simply supplied in this regression as a revenue shifter, and is not part of the Panzar-Rosse H-Statistic calculation, we do not find issue with these findings. *Income* has a positive effect on revenue showing a one percent increase in income providing a 0.0003percent increase in revenue. This is insignificant; however, on the 95 percent confidence interval most likely due to the fact that there are a lot of repeated values in the time series data. The real price of substitutes (*RPS*) also shows a positive effect on revenue which makes sense because an increase in the price of substitutes will naturally lead to an increase in firm revenue in this industry due to the substitution effect. The coefficient is insignificant; however, on the 95 percent confidence interval. Again, this does not cause issue because there are several substitutes and vary widely.

The *Trend* variable shows a negative effect on revenue because it is showing the decrease in demand for the goods produced in the dried plums industry. This coefficient was found to be significant at the 95 percent confidence interval.

In looking at the firm dummy variables and the *Constant*, it is evident that the *Constant*, Sunsweet Cooperative, has higher average revenues than the other two competing firms in the model; Del Monte and Dole. The firm dummy variables for Del Monte and Dole, as well as the constant are all significant on the 95 percent confidence interval showing that the model is a good fit for the data. The adjusted R^2 for this model is 0.9836, which is concurrent with a representation of time series data.

Model 2 Results Discussion

Model 2 is very similar to Model 1, except for it excludes farm price. This exclusion did not change the coefficient values nor their significance enough to warrant further discussion of the findings in this model versus that of Model 1.

Model 3 Results Discussion

Model 3 includes farm price again and replaces the revenue shifter Producer Price Index (*PPI)*,with the Consumer Price Index (*CPI)*. The coefficients of *ln(%ACVD), ln (%ACVF), ln(%ACVFD), ln(SunTV),* and *ln(FarmP)* are all very similar to the findings in Model 1. The advertising expenditures *ln(%ACVD), ln (%ACVF),* and *ln(%ACVFD)* all have positive effects on revenue and all are significant on the 95 percent confidence interval. *ln(SunTV)* and *ln(FarmP)* have negative effects on revenue and remain insignificant on the 95 percent confidence interval as discussed in the Model 1 results discussion.

The inclusion of the Consumer Price Index (*CPI*) in the model shows it as having a positive effect on revenue which makes sense because it shows an increase in the willingness of consumers to pay a higher price for products which would lead to an increase in revenue. The coefficient is insignificant on the 95 percent confidence interval; however, most likely due to the lack of variation during the time periods in which the *CPI* was examined for this model. The *Income* coefficient retains its positive effect on revenue and its significance as with the previous models.

The *Trend* variable has a very similar coefficient of that of the first two models, but is insignificant on the 95 percent confidence interval, unlike in the first two models. The reason behind this is unknown for sure, but one hypothesis is tested in Model 4. See the Model 4 results discussion for further discussion of change in significance.

The firm level dummy variables have similar coefficients as the first two models and remain significant on the 95 percent confidence interval. The *Constant*; however, retains its positive effect on revenue, but is insignificant on the 95 percent confidence interval. The adjusted R^2 value is also very similar to the previous two models showing that this data is a good fit for this model.

Model 4 Results Discussion

Model 4 is the same as Model 3, except for the *Trend* variable is logged in order to test for underlying trend in the data. *ln(%ACVD), ln (%ACVF),* and *ln(%ACVFD)* all retain their positive influences on revenue and all are significant. *ln(SunTV)* retains its negative effect on revenue and also remains insignificant on the 95 percent confidence interval. There is a drastic change; however, in *ln(FarmP)*. While farm price still has a negative effect on revenue, its coefficient is drastically greater at -0.4292 and while the coefficient remains insignificant, it is much closer to being significant with a t-statistic value of -1.53.

There is also a change seen in *CPI*, which now has a negative impact on revenue, but it remains insignificant on the 95 percent confidence interval. The *Income* coefficient remains very similar to Models 1, 2, and 3 by retaining its positive effects on income and its insignificance. Real price of substitutes (*RPS*), while retaining its positive impact on revenue, has a decrease in coefficient value in comparison to the *RPS* coefficients in Models 1, 2, and 3(0.0779057 for Model 4 versus 0.3840701, 0.3855784, and 0.3550337 for Models 1, 2, and 3 respectively). It still retains its insignificance; however.

By logging the *Trend* variable, we see that the trend variable has a positive effect on revenue, which is different than Models 1, 2, and 3 which all show the trend variable as having a negative impact on revenue. The *ln(Trend)* variable is insignificant at the 95 percent confidence interval. Model 4 does not agree with the results of the previous three models as seen later when calculating the H-Statistic, but was included here a useful comparison and test of whether there is an unknown underlying trend in the data. The adjusted R^2 value is also very similar to the previous two models showing that this model is a good fit for these data.

Regression Results and Discussion: 2008-2010

Table 4-2:Regression Results: 2008-2010

Variable	Model 1	Model 2	Model 3	Model 4
ln(%ACVD)	.06771 (.0088371) [7.66]*	.068853 (.0088114) [7.81]*	.0696042 (.0086433) [8.05]*	.0706655 (.0087294) [8.10]*
ln(%ACVF)	.011497 (.0033057) [3.48]*	.0114281 (.0033086) [3.45]*	.0115785 (.0032353) [3.58]*	.0113581 (.0032694) [3.47]*
ln(%ACVFD)	.0103334 (.0039553) [2.61]*	.0105112 (.0039573) [2.66]*	.0106696 (.0038765) [2.75]*	.0114591 (.0039151) [2.93]*
ln(SunTV)	.004968 (.0015087) [3.29]*	.0048822 (.0015091) [3.24]*	.0044805 (.00148) [3.03]*	.0044855 (.0014955) [3.00]*
ln(FarmP)	.1783144 (.1215028) [1.47]	-	.0282404 (.1020929) [0.28]	-0.0654514 (.106911) [-0.61]
ln(PPI)	-.6237238 (.1206016) [-5.17]*	-.5228368 (.0991883) [-5.27]*	-	-
CPI	-	-	-8.076169 (1.126525) [-7.17]*	-5.358843 (.8801117) [-6.09]*
Income	.0002429 (.0000204) [11.88]*	.0002475 (.0000202) [12.24]*	.0000454 (.000039) [1.17]	.0000968 (.0000367) [2.64]*
RPS	-.5865391 (.2116571) [-2.77]*	-.60212217 (.2115986) [-2.85]*	-.659716 (.2077031) [-3.18]*	-.7043164 (.2095129) [-3.36]*
Trend	.0008932 (.0003435) [2.60]*	.0004682 (.000185) [2.53]*	.0019509 (.0003993) [4.89]*	-
ln(Trend)	-	-	-	.0391208 (.0116253) [3.37]*
PLD	-2.274526 (.4557188) [-4.99]*	-2.308229 .4555876 [-5.07]*	-2.434473 (.4472116) [-5.44]*	-2.528602 (.4511369) [-5.60]*
CAD	-5.604304 (.4562114) [-12.28]*	-5.636468 (.456133) [-12.36]*	-5.760951 (.4477277) [-12.87]*	-5.853216 (.4516933) [-12.96]*

Continued.

Variable	Model 1	Model 2	Model 3	Model 4
DMD	-4.103946 (.4582231) [-8.96]*	-4.132741 (.4582533) [-9.02]*	-4.254742 (.4497255) [-9.46]*	-4.343241 (.4537806) [-9.57]*
MAD	-3.561305 (.4556399) [-7.82]*	-3.595543 (.45549) [-7.89]*	-3.721343 (.4471516) [-8.32]*	-3.815778 (.4510708) [-8.46]*
SMD	-3.575449 (.455745) [-7.85]*	-3.608311 (.4556425) [-7.92]*	-3.733348 (.447247) [-8.35]*	-3.825763 (.4512) [-8.48]*
DD	-	-	-	-
Constant	7.776128 (1.185989) [6.56]*	8.445304 (1.095909) [7.71]*	20.96173 (2.417487) [8.67]*	17.1462 (2.230874) [7.69]*
Adjusted R^2	**0.9929**	**0.9928**	**0.9931**	**0.9930**

** Indicates statistically significant at 95% Confidence Interval*

Model 1 Results Discussion

Table 4.2 present the regression results for the more recent data set. In examining Model 1, we see that advertising display (*ln(%ACVD)*), advertising feature (*ln (%ACVF)*), and the combination of advertising display and feature (*ln(%ACVFD)*) all have a positive effect on revenue and all coefficients are statistically significant at the 95 percent confidence interval. Again, this is to be expected because advertising and promotions are meant to increase revenues. With a one percent increase in advertising display expenditures, there is an expected 0.06771 % increase in revenue. With a one percent increase in advertising feature expenditures, there is an expected 0.011497 % increase in revenue. With a one percent increase in a combination of both display and feature advertising, there is an expected 0.0103334 % increase in revenue.

Unlike the previous data set, in the more recent data set, Sunsweet's TV advertising expenditures (*SunTV*) were found to have a positive effect on revenue and its coefficient is significant on the 95 percent confidence interval. With a-one percent increase in TV advertising expenditures, there is expected to be a 0.004968% increase in revenue. Farm price (*FarmP*) was also found to have a positive effect on revenue and its coefficient is significant at the 95 percent confidence interval.

The Producer Price Index (*PPI*) was found to have a negative impact on revenue and its coefficient was significant at the 95 percent confidence interval. This could be due in part to the increase in price of dried plums to the processors; therefore, leading to higher input costs.

Income has a positive effect on revenue and is statistically significant on the 95 percent confidence interval. This is an obvious trend because as income increasing, consumer purchasing power increases, thus leading to an increase in revenue. The real price of substitutes has a negative effect on revenue and is significant on the 95 percent confidence interval. This is due to decline in overall purchase of dried plums and the increase purchase of substitutes.

The *Trend* variable has a positive effect on revenue and its coefficient is significant on the 95 percent confidence interval. This could be due to the product differentiation strategies that firms are implementing in order to combat the aforementioned decline in the purchase of dried plums.

All of the firm level dummy variables have negative coefficients meaning that the *Constant*, Sunsweet, has the highest average revenue in the industry. All of the firm level dummy variable coefficients and the *Constant* are significant at the 95 percent confidence interval. The adjusted R^2 value is 0.9929 which is consistent with time series data. It also demonstrates that this model is a good fit for these data.

Model 2 Results Discussion

Model 2 is very similar to Model 1, except for it excludes farm price. This exclusion did not change the coefficient values or their significance enough to warrant further discussion of the findings in this model versus that of Model 1.

Model 3 Results Discussion

Model 3 includes farm price again and replaces the revenue shifter Producer Price Index (*PPI),*with the Consumer Price Index (*CPI)*. The coefficients of *ln(%ACVD), ln (%ACVF), ln(%ACVFD), ln(SunTV),* and *ln(FarmP)* are all very similar to the findings in model one. The advertising expenditures *ln(%ACVD), ln (%ACVF),* and *ln(%ACVFD)* all have positive effects on revenue and all are significant on the 95 percent confidence interval. *ln(SunTV)* and *ln(FarmP)* have positive effects on revenue and remain insignificant on the 95 percent confidence interval as discussed in the Model 1 results discussion.

The inclusion of the Consumer Price Index (*CPI*) in the model shows it as having a negative effect on revenue. This negative effect could be due volatility in *CPI* values during 2008 through 2010. The coefficient is significant on the 95 percent confidence interval. *Income* retains its positive impact on revenue and its significance as with the previous two models.

The *Trend* variable retains its positive coefficient and its significance. The firm level dummy variables have similar coefficients as the first two models and remain significant on the 95 percent confidence interval. The *Constant* also retains its positive effect on revenue and its significance. The adjusted R^2 value is also very similar to the previous two models showing that this data is a good fit for this model.

Model 4 Results Discussion

Model 4 is the same as Model 3, except for the *Trend* variable is logged. All the results are very similar to Model 3 for all of the variables, except for farm price. The impact of *FarmP* became a negative effect on revenue, but retained its insignificance.

Differences in Results between Data Sets

Comparisons of the two data sets are cautionary because one data set is longer than the other. During the time period of 1992 through 1996, the farm price (*FarmP*) has a negative effect on income. During the time period of 2008 through 2010, farm price had a positive effect on income. This could be due to the differences in farm prices and the increase in purchasing power of the processors. *Income* was insignificant for all models in the 1992 through 1996 data set, and significant for Models 1, 2, and 4 in the 2008 through 2010 data set.

The real price of substitutes (*RPS*) had a positive effect on income for all models during the 1992 through 1996 time period, and had a negative impact on revenue for the 2008 through 2010 time period. In the first data set, the real price of substitutes has a positive impact because of the substitution effect. As the price of substitutes rises, the revenue for the dried plum industry rises as consumers look for cheaper alternatives. The negative impact on revenue seen in years 2008 through 2010 can be demonstrative of a decline in dried plum consumption, a demand for substitutes, and substitutes being sold at lower prices. The *RPS* values were also insignificant for 1992 through 1996 and significant for 2008 through 2010.

Other small differences include the effect of *CPI* on income in Model 3. In 1992 through 1996, *CPI* had a positive effect on revenue. In 2008 through 2010, *CPI* had a negative effect on revenue which could be due to volatility in *CPI* values. Finally, *ln(Trend)* was insignificant for Model 4 for 1992 through 1996, and significant for 2008 through 2010. These results are now used to formulate the H-Statistic found in Chapter 5.

Chapter 5 - Panzar-Rosse H-Statistic

The following is a review of the methods used to calculate the Panzar-Rosse H-Statistic, the H-Statistics calculated for both data sets, and a discussion of these results.

H-Statistic Formulation

As aforementioned in Chapter 2, the Panzar-Rosse H-Statistic is the sum of all of the elasticities of a firm's total revenue with respect to factor input prices focusing on the long-run equilibrium. In this particular case, the coefficients were taken from the following variables in the regressions in Chapter 4: *ln(%ACVD), ln(%ACVF), ln(%ACVFD), ln(SunTV), and ln(FarmP)* and adding these coefficients results in the H-Statistic. Once calculated, the H-Statistic can be interpreted to determine if the industry is monopolistic, monopolistically competitive, or perfectly competitive. $H<0$ if an industry is monopolistic (e.g. firms are behaving collusively), $0<H<1$ if an industry is monopolistically competitive, and $H=1$ if the industry is perfectly competitive.

Once the H-Statistic is calculated, because the underlying distribution of each coefficient is assumed normal and because the H-Statistic is a simple sum, the standard error for the H-Statistic itself can be derived by adding the coefficient standard errors as well. A 95 percent confidence interval is then derived. The following pages (Table 5.1 and Table 5.2) present the coefficients of each variable for each model, along with the standard error, variance, H-Statistic, H-Variance, and whether or not the H-Statistic is statistically significant or not.

Table 5-1:Panzar-Rosse H-Statistics, 1992-1996

Model 1	Coefficient	Standard Error	Variance
ln(%ACVD)	0.043279	0.006111	3.73382E-05
ln(%ACVF)	0.026336	0.005692	3.23954E-05
ln%(ACVFD)	0.023147	0.006414	4.1133E-05
ln(SunTV)	-0.01718	0.031742	0.001007523
ln(FarmP)	-0.00477	0.204323	0.041747807
H-Statistic	0.070813* S.E.:	0.25428 H-Var:	0.042866196
H-Stat – *ln(FarmP)*	0.075578*	H-Var – *ln(FarmP)*	0.001118389

Model 2	Coefficient	Standard Error	Variance
ln(%ACVD)	0.043263	0.006048	3.65771E-05
ln(%ACVF)	0.026324	0.005647	3.1892E-05
ln%(ACVFD)	0.023166	0.006339	4.01842E-05
ln(SunTV)	-0.0172	0.031624	0.00100009
ln(FarmP)	-	-	-
H-Statistic	0.075552* S.E.:	0.0496585 H-Var:	0.001108743

Model 3	Coefficient	Standard Error	Variance
ln(%ACVD)	0.0430762	0.006227	3.87705E-05
ln(%ACVF)	0.026629	0.005672	3.21659E-05
ln%(ACVFD)	0.02306	0.006445	4.15354E-05
ln(SunTV)	-0.01522	0.032068	0.001028363
ln(FarmP)	-0.00453	0.210345	0.044244851
H-Statistic	0.073013* S.E.:	0.2607556 H-Var:	0.045385686
H-Stat – *ln(FarmP)*	0.077541*	H-Var – *ln(FarmP)*	0.001140835

Model 4	Coefficient	Standard Error	Variance
ln(%ACVD)	0.042003	0.006191	3.83297E-05
ln(%ACVF)	0.025947	0.005679	3.22465E-05
ln%(ACVFD)	0.022667	0.006461	4.17432E-05
ln(SunTV)	-0.02585	0.032555	0.001059802
ln(FarmP)	-0.42925	0.281384	0.079177012
H-Statistic	-0.36449* S.E.:	0.3322693 H-Var:	0.080349133
H-Stat – *ln(FarmP)*	0.064765*	H-Var – *ln(FarmP)*	0.001172121

Note: * *Statistically Significant from Zero and One at 95 Percent Confidence Interval*

Table 5-2:Panzar-Rosse H-Statistics, 2008-2010

Model 1	**Coefficient**		**Standard Error**		**Variance**
ln(%ACVD)	0.06771		0.008837		0.0000780943
ln(%ACVF)	0.011497		0.003306		0.0000109277
ln%(ACVFD)	0.010333		0.003955		0.0000156444
ln(SunTV)	0.004968		0.001509		0.00000227618
ln(FarmP)	0.178314		0.121503		0.01476293
H-Statistic	**0.272823***	**S.E.:**	**0.13911**	**H-Var:**	**0.014869873**
H-Stat – *ln(FarmP)*	**0.094508***		**H-Var – *ln(FarmP)***		**0.000106943**
Model 2	**Coefficient**		**Standard Error**		**Variance**
ln(%ACVD)	0.068853		0.008811		0.0000776408
ln(%ACVF)	0.011428		0.003309		0.0000109468
ln%(ACVFD)	0.010511		0.003957		0.0000156602
ln(SunTV)	0.004882		0.001509		0.00000227738
ln(FarmP)	-		-		-
H-Statistic	**0.095675***	**S.E.:**	**0.017586**	**H-Var:**	**0.000106525**
Model 3	**Coefficient**		**Standard Error**		**Variance**
ln(%ACVD)	0.069604		0.008643		0.0000747066
ln(%ACVF)	0.011579		0.003235		0.0000104672
ln%(ACVFD)	0.01067		0.003877		0.0000150273
ln(SunTV)	0.004481		0.00148		0.0000021904
ln(FarmP)	0.02824		0.102093		0.01042296
H-Statistic	**0.124573***	**S.E:**	**0.119328**	**H-Var:**	**0.010525352**
H-Stat – *ln(FarmP)*	**0.096333***		**H-Var – *ln(FarmP)***		0.000102391
Model 4	**Coefficient**		**Standard Error**		**Variance**
ln(%ACVD)	0.070666		0.008729		0.0000762024
ln(%ACVF)	0.011358		0.003269		0.000010689
ln%(ACVFD)	0.011459		0.003915		0.000015328
ln(SunTV)	0.004486		0.001496		0.00000223652
ln(FarmP)	-0.065451		0.106911		0.011429962
H-Statistic	**0.032517**	**S.E.:**	**0.12432**	**H-Var:**	**0.011534418**
H-Stat – *ln(FarmP)*	**0.097968***		**H-Var – *ln(FarmP)***		**0.000104456**

Note: * *Statistically Significant from Zero and One at 95 Percent Confidence Interval*

Discussion of H-Statistic Results

In examining the H-Statistics calculated for years 1992 through 1996, Model 1 has a H-Statistic of 0.07; Model 2, H=0.08; and Model 3, H=0.07. All three H-Statistics for these models are statistically significant at the 95 percent confidence interval; therefore, these H-Statistics are significantly different from zero and from one, the two bounds of the market structure under the Panzar-Rosse test. This is important in our analysis because as stated in the introduction for this chapter, $H<0$ for monopoly (an industry that is acting collusively), $0<H<1$ for monopolistic competition, and $H<1$ for perfect competition. These three models suggest then that the dried plums industry, while very near zero (monopoly), was monopolistically competitive in this earlier time period.

The fourth model; however, shows us very different results. The H-Statistic for Model 4 is -0.36. The H-Statistic is statistically significant at the 95 percent confidence interval. Recall that Model 4 is different than the previous three models in that the *Trend* variable is logged in an effort to insure there aren't any underlying trend variables. By doing so, it drastically changed the farm price (*FarmP*) coefficient. This could be due in part because the farm price that we have made available to us is on a monthly basis, versus the other data, which is weekly basis. This model then suggests that the dried plum industry was monopolistic during this early time period. However, given the high R-Square values in each model and that the insignificant *FarmP* coefficients in Models 1, 2, and 3 change sign and magnitude so dramatically while remaining insignificant in Model 4 suggests there is a problem with this variable. This is not surprising as *FarmP* was an annual observation so has almost no variation within the sample. Striking *FarmP* from the analysis due to its insignificance would keep the H-Statistic in the monopolistic competition range as shown in the above tables.

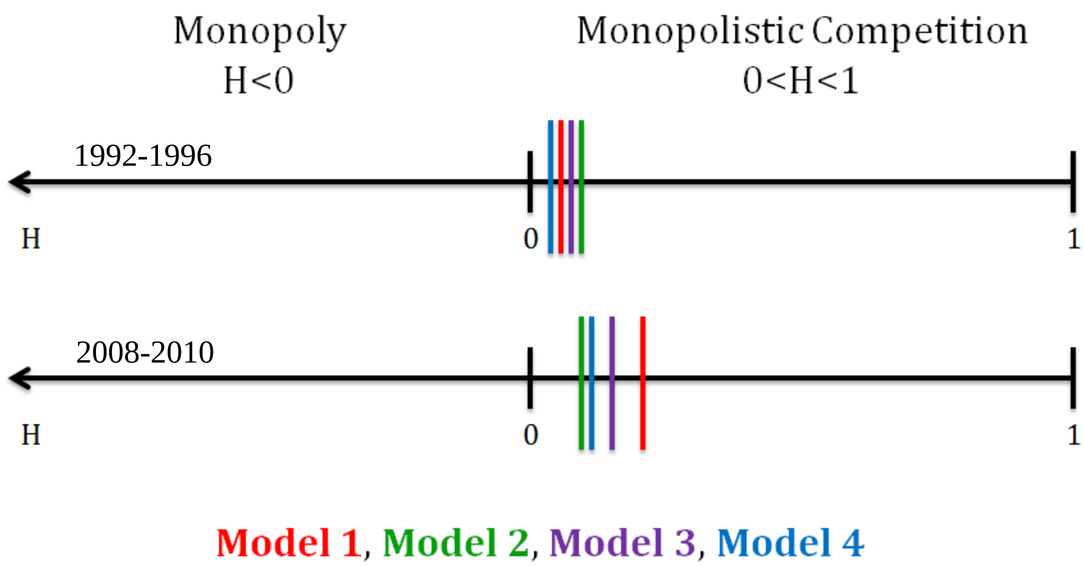
In examining the H-Statistics calculated for years 2008 through 2010, Model 1 has a H-Statistic of 0.27; Model 2, H=0.09; Model 3, H=0.12; Model 4, H=0.03. All four H-Statistics are statistically significant at the 95 percent confidence interval; therefore, these H-Statistics are significantly different from zero and one. Again, this is important because of the H-Statistic parameters aforementioned. These four models suggest that the dried plum industry is monopolistically competitive and not very different from what was found in the earlier data set.

Shifts in H-Statistic Values

In comparing the H-Statistic values for each model between the two data sets, we see Model 1 shows an increase (0.07 to 0.27) in H-Statistic values, which demonstrates a shift within the monopolistic competitive industry structure closer to the perfect competition end of the spectrum. Model 2 also shows a very slight increase (0.07 to 0.09) demonstrating similar results as with Model 1. Model 3also sees an upward shift in H-Statistic values (0.07 to 0.12) which, while this is still representative of a monopolistically competitive industry structure, moves closer to the perfect competition end of the spectrum. Model 4 sees an increase (-0.36 to 0.03) showing a shift from the monopolistic industry structure to monopolistically competitive. However, if we strike *FarmP* from the calculation of the H-Statistic because the coefficient is always insignificant yet its sign and magnitude changes so much in Model 4, we find that the H-Statistic shifts from 0.06 to 0.1 which would keep within the monopolistic competitive range for both the earlier and later data sets. A visual comparison of the H-Statistic values between the two data sets can be seen in Figure 5.1 on the following page.

Before completing this study, we hypothesized that we would see that the dried plums market was shifting from an industry that participates collusively with few firms to a monopolistically competitive firm with the addition of market entrants between the time of each of the data set compilations. After completing the study, we are unable to say that this is happening definitively because of the differences in shifts of the H-Statistics for each of the models between each of the data sets.

Figure 5-1: H-Statistic Value Shifts



*Note: Model 4 is shown with the *H-Stat* striking *FarmP* from the calculation due to the poor specification of that variable. The regression itself is unchanged.

Chapter 6 - Conclusion

This analysis examines the industry structure of the dried plums market through the use of the Panzar-Rosse test for industry structure and the analysis of the Panzar-Rosse H-Statistic. Based on the parameters of the H-Statistic calculation, regression equations were calculated to determine the elasticities of the input costs and other exogenous costs affecting the industry. Once calculated, the coefficients of the input costs for *%ACVD*, *%ACV F*, *%ACVFD*, *SunTV*, and *FarmP* were summed in order to find the H-Statistic for each model.

The resulting H-Statistics for the first data set (1992-1996) were 0.07, 0.08, 0.07 and --0.36 and were all statistically significant on the 95 percent confidence interval. In using the H-Statistic parameters: $H<0$ if an industry is monopolistic (e.g. firms are behaving collusively), $0<H<1$ if an industry is monopolistically competitive, and $H=1$ if the industry is perfectly competitive; we found that the first three H-Statistics suggest that the dried plums industry is monopolistically competitive, while the fourth model suggests that the dried plums industry is acting collusively (or monopolistically). However, if we examine Model 4 further, and strike the coefficient on *FarmP* from its construction because of the data issues, we find that the new H-Statistic is 0.06, consistent with the findings of the other models, suggesting that the dried plums industry is monopolistically competitive.

The resulting H-Statistics for the second data set (2008-2010) were 0.27, 0.01, 0.12, and 0.03 and were all statistically significant on the 95 percent confidence interval. In using the H-Statistic parameters aforementioned, all four H-Statistics suggest that the dried plums market is monopolistically competitive. As with the previous data set, if we examine Model 4 further, and strike the coefficient from the problematic *FarmP* variable in the construction of the H-statistic we find that the new H-Statistic is 0.09; further suggesting that the dried plums industry is monopolistically competitive and, again viewing a result consistent with the other models.

In examining the evolution of the dried plums industry from the time period of the first data set (1992-1996) through the time period of the second data set (2008-2010) we found some interesting, though minor, shifts in H-Statistic values. Once the problematic *FarmP* variable is accounted for in Model 4, we find that the industry has become slightly more competitive over the years, but still monopolistically competitive.

Overall, based both on the insight of the industry from the published literature and our results here, we would conclude that there is fair evidence that the dried plums market is operating under monopolistic competition. This study is further useful because it provides evidence that the dried plums industry is monopolistically competitive, it confirms assertions made in previous published studies and confirms their findings about the dried plums industry. Future studies may include data that is collected in smaller time intervals (i.e. weekly versus monthly); more detailed data on specific input costs and exogenous costs from each firm, and further econometric testing to determine the validity of the firm-level panel data presented. Overall this study provides insightful information on the industry structure of this small, niche agricultural market.

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