Grocery Retailer Pricing Behavior for California Avocados with Implications for Industry Promotion Strategies

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Abstract

Retailers are becoming the dominant player in the food chain in the U.S. and other countries. Retailer market power is a topical issue in light of rising concentration and consolidation in the grocery retail sector, emerging trade practices between retailers and upstream suppliers, and a growing body of conceptual bases and empirical evidence regarding retailer market power. Most likely, the key question is not whether retailers have the ability to influence price, but, rather, the extent and implications of that influence. Understanding retailer pricing behavior is critical to the assessment of retailer market power.

Using a unique micro dataset, this paper examines retailer pricing behavior for avocados, in particular the effects of the underlying demand and cost factors on determination of retail prices. The study also provides evidence regarding the effectiveness of the avocado industry's promotion policies in view of retailer pricing behavior for avocados. Although the application is for avocados, a key California specialty commodity, the methodologies developed and the results achieved in this study should have broad applications across the food industry and the grocery retail market.

The study illustrates that retail prices for avocados were highly dispersed both spatially and temporarily. There was evident heterogeneity of retail prices for avocados of different sizes sold at different retail chains and in different markets. The analysis shows the existence of a "regular" retail price for avocados. Downward deviations from the "regular" price dominated changes in retail prices, in particular, temporary price reductions accounted for 27 percent of quarterly retail price variations.

The study examines how retailers adjust retail prices in response to changes in demand and cost factors. We conclude that costs are not a primary factor in setting retail prices for avocados. Retailers' sales strategies, which reflect decreases in retail margins rather than decreases in costs, explained much of the observed temporary price reductions for avocados. Retail prices for avocados also exhibited countercyclical movements over seasonal demand cycles. The findings provide support for Lal and Matutes' (1994) hypothesis that retailers reduce prices or margins during a product's high-demand periods in order to compete with each other for consumers' store patronage.

Other noteworthy results include the fact that retail margins increased significantly as shipment volumes increased, indicating the presence of retailer oligopsony power. Also notable was the rather strong evidence that retail prices were significantly lower as a function of the amount of avocados imported from Chile and Mexico, meaning that consumers have benefited from trade liberalization for avocados.

How retailers set price in response to demand shocks is important in the context of agricultural industries' efforts to promote and market their products. The approach of "Difference-in-Difference" is employed to evaluate the effects of the California Avocado Commission's (CAC) promotion programs on retail price and sales. The analysis demonstrates that the radio campaign and outdoor advertisements were successful in raising avocado sales. There is no evidence that retailers charged higher prices during the CAC's promotions. Nonetheless, the CAC's promotion programs could be enhanced if retailers were better informed about the advertising campaigns.

JEL Classification Numbers: F13, L13, L66, L81, M30, Q13, Q17.

I. Introduction

Rising concentration and consolidation of sales among large supermarket chains in the U.S. and other countries, due in part to a recent wave of mergers in food retailing,[1] have made retailers' role in the food industry a topical issue. Several conceptual bases and empirical evidence support the hypothesis that grocery retailers are likely to possess some degree of market power in the sense of influencing the prices they pay to suppliers and charge to consumers. These considerations include the multiproduct nature of retailing and consumers' preferences for one-stop shopping, the spatial dimension of retail markets, imperfect information, differentiation of marketing strategies among retailers, and the rising concentration in local food retail markets.[2] Most likely, the key question is not whether retailers have the ability to influence price, but, rather, the extent and implications of that influence. Understanding retailer pricing behavior is critical to the assessment of retailer market power.

Using a unique micro dataset, this paper investigates retailer pricing issues for avocados, a key California specialty commodity, and analyzes the implications of retailer behavior for the effectiveness of avocado industry advertising programs. Through the

[1] See Kaufman (2000), Kaufman *et al.* (2000), and Harris *et al.* (2002) for recent summaries of merger and acquisition activities in U.S. grocery retailing. See Cooper (2003) and Dobson, Waterson, and Davies (2003) for summaries of concentration issues in European food retailing.

[2] For discussions of the multiproduct nature of grocery shopping and retailing, see Bliss (1988), Giulietti and Waterson (1997), Lal and Matutes (1994), and Hosken and Reiffen (2001, 2004b); for discussions of food retailing from a spatial economics perspective, see Benson and Faminow (1985), Faminow and Benson (1985), Walden (1990), and Azzam (1999); for discussions of imperfect information in retail markets, see Salop (1976, 1977), Salop and Stiglitz (1977, 1982), Varian (1980), Sobel (1984), Lal and Matutes (1994), Hosken and Reiffen (2001, 2004b), and Pesendorfer (2002); for discussions of differentiation of pricing and marketing strategies among retailers, see Salop and Stiglitz (1982), Varian (1980), Lal and Rao (1997), Boatwright, Dhar, and Rossi (2004), Pesendorfer (2002), and Sexton, Zhang, and Chalfant (2003); for discussions of concentration and retailer market power, see Cotterill's (1993) part 5 for a debate on the issue of market power in grocery retailing, and Connor (1999) and Wright (2001) for recent critiques of research into the concentration-price relationship in grocery retailing.

auspices of the California Avocado Commission, the industry expends over $5 million annually for advertising programs in the U.S.

Empirical studies, such as Pesendorfer (2002), and Sexton, Zhang, and Chalfant (SZC, 2003), document a remarkable degree of cross-sectional price dispersion among food retailers within a SMSA and intertemporal price variations for a given retailer. For example, some retailers choose to maintain very stable retail prices for produce commodities, despite large fluctuations in the price at the farm gate, while other retailers use produce commodities as frequent sale items (SZC, 2003). In general, variations in retail prices seem at best loosely related to changes in wholesale prices (MacDonald, 2000; Chevalier, Kashyap, and Rossi (CKR), 2003; SZC, 2003; Hosken and Reiffen, 2004a, 2004b; Li and Sexton, 2005). There is also a growing body of evidence that retail prices fall in periods of high demand (e.g., Warner and Barsky, 1995; MacDonald, 2000; CKR, 2003; Hosken and Reiffen, 2004b), a result inconsistent with a perfect competition model of pricing, or with standard models of oligopoly, such as Bertrand or Cournot.

Although the possibility of retailer market power in selling to consumers has been studied extensively (see footnote 2), retailers' role as buyers from commodity shippers and food manufacturers has received comparatively little attention. Both the structure of these markets and emerging trade practices suggest the increasing retailer power in procurement activities in the produce industry (Rogers and Sexton, 1994; Calvin, Cook, *et al.*, 2001). Prior research has shown that retail buyers may be able to capture large shares of the market surplus for produce commodities (Sexton and Zhang, 1996; Richards and Patterson, 2003; SZC, 2003).

These issues of retailer pricing behavior are of particular importance in the context of agricultural industries' efforts to promote and market their products. Many agricultural industries have utilized industry-wide promotion programs funded by producer and/or handler assessments as a tool to increase sales and producer incomes. Expenditures on these programs in California alone totaled $141.5 million in 2002.

Various studies have shown that these programs are often quite successful in generating a high return on the dollars invested (Kaiser *et al*. 2005). However, most of these studies have been conducted using aggregate, industry-wide data (e.g., Alston *et al*. 1997, 1998; Carman and Craft, 1998) and, thus, can provide little guidance in terms of targeting advertising to cities or retailers, and determining which types of campaigns are most effective. Moreover, little is known about how the effectiveness of these programs is facilitated or impeded by retailers' own pricing strategies. For example, if retailers respond to a commodity advertising campaign by raising prices to consumers to absorb any demand increase induced by the promotion, the higher sales that are needed to induce an increase in the producer price will not materialize.

The rest of paper proceeds as follows. Section II reviews literature on retailer pricing behavior and studies on trade practices in the produce industry. Section III gives an overview of the Californian avocado industry. Datasets utilized in this study are described in Section IV. Section V provides descriptive documentation of several important features of retailer pricing behavior for avocados. The approach of Difference-in-Difference, which is employed to identify the "treatment effects" of the CAC's promotion programs, is discussed in Section VI. Section VII presents the empirical models and hypothesis tests that examine retail sales and retailer pricing behavior for avocados. Section VIII discusses the results, and Section IX concludes.

II. Literature Review

Most retail markets are characterized by a large degree of price variations manifested both spatially and temporarily instead of by the "law of one price". Grocery retail markets exhibit temporal price variations, with stores deliberately varying their prices over time, and cross-section price dispersion with stores offering an identical item at different prices at any point of time (Pesendorfer, 2002; SZC, 2003).

Temporary price reduction is a widely observed phenomenon in the grocery retail market. It is a common observation that only a small fraction of numerous goods carried by grocery retailers are offered at low "sale" prices each week, and those selected items tend to change over time. Hosken and Reiffen (2004a) analyze retail prices for twenty categories of grocery goods in thirty geographic areas. They show that a typical grocery product has a "regular" price, and that most deviations from the regular price are downward and short-lived. Temporary price reductions account for 20 to 50 percent of annual variations in retail prices for the grocery products in their study. Li and Sexton (2005) also find a similar price pattern for lettuce and bagged salad products at twenty retail chains in six metropolitan areas in the U.S. Temporary price reductions explain 20 and 45 percent of annual variations in retail prices for lettuce and bagged salad products, respectively. However, variations in retail prices seem loosely related to changes in the prices in the upstream market (MacDonald, 2000; CKR, 2003; SZC, 2003; Hosken and Reiffen, 2004a, 2004b; Li and Sexton, 2005).

Trade practices in the produce industry suggest that retail chains usually buy produce commodities directly from grower-shippers rather than buy from local wholesale markets (Calvin, Cook, *et al.*, 2001). This is also true in the avocado industry. Under the classical models of the farm-retail price spread (e.g., George and King, 1971), where retailers add some type of fixed or percentage markup to the raw product price, we would expect changes in shipping-point prices to pass through to retail prices, possibly with some lag.

Concentration in the food retail sector leads to suspicions about retailers' oligopsony power in buying from food manufacturers or producers. Emerging trade practices between fresh produce shippers and food retailers also suggest the increasing retailer power in procurement practices (Calvin, Cook, *et al*., 2001). Traditionally, the fresh produce industry has emphasized daily, spot-market sales. However, the use of price arrangements, such as advance pricing and short- and long-term contacts, is becoming more common. [3] One of the consequences of these price arrangements is that seasonal supply shocks from the farm level may not effectively transmit to the retail level.

Moreover, the economic basis for concerns about buyer power is strong, particularly for specialty commodities such as fresh fruits and vegetables, where shippers are small and unconcentrated relative to buyers, and often sell highly perishable commodities (Rogers and Sexton, 1994). Evidence suggests that buyers use large harvests (abundant supplies) to further bid down prices for perishable commodities and increase the farm-retail price spread during those periods (Sexton and Zhang, 1996; SZC, 2003).

On the side of selling to consumers, grocery retailers conduct temporary price reductions on a regular basis. This suggests that these price changes are not due entirely to random shocks in costs or demand. Empirical evidence suggests that temporary price reductions are attributable to retailers' sales strategies, which are the result of decreases

[3] Advance-pricing agreements typically specify a price ceiling, commonly referred as a lid price, for an estimated volume in a certain future period (usually a few weeks in advance). However, they do not involve a formal purchase commitment (Calvin, Cook, *et al*., 2001).

in margins rather than decreases in costs (MacDonald, 2000; CKR, 2003; Hosken and Reiffen, 2004a, 2004b; Li and Sexton, 2005). Attempts have been made in the literature on retailer pricing behavior to understand the existence and persistence of the sale phenomenon.

A seminal paper by Salop and Stiglitz (1977) offers an explanation for the observation that several stores contemporaneously offer an identical item at different prices. They consider a single-product market with two kinds of consumers. Consumers differ in their costs of information acquisition. Stores behave as monopolistically competitive price setters with zero profits. Salop and Stiglitz show that for some parameter configurations, a two-price equilibrium exists. Low information-cost consumers are informed about the entire distribution of the offered prices, and high information-cost consumers choose to remain uninformed about the price distribution. Hence, informed consumers always go to a low-priced store, while uninformed consumers shop at random. In the equilibrium, some stores sell at the perfectly competitive price (minimum average cost), and the rest only sell to uninformed consumers at a higher price. The lower volume of the high-price stores exactly compensates for the higher profit per sale, which ensures the zero profit condition in the equilibrium.

Based on Salop and Stiglitz's model, some stores sell the product permanently at a lower price than other stores. Varian (1980) points out that if consumers can learn from experience, the persistence of price dispersion seems rather implausible. Varian shows how stores may find it in their interests to randomize prices of an identical product in an attempt to price discriminate between informed and uninformed consumers. Similar to Salop and Stiglitz (1977), Varian assumes two types of consumers. In each period, each retailer randomly chooses a price from a continuous price distribution, and decides between obtaining a high price and selling only to those uninformed consumers, and charging a low price and selling to informed consumers as well. Retailers earn zero profits.

Varian shows that the resulting monopolistically competitive equilibrium features mixed strategies, in which each retailer changes its price each period and no specific price is charged with positive probability mass. Stores tend to charge extreme prices with higher probability, either the perfectly competitive price (the average cost associated with the number of customers) or the monopolistically competitive price (the reservation price), than they charge intermediate prices.

Lal and Matutes (1994) utilize the multiproduct nature of retailing and develop a model to explore equilibrium pricing and advertising strategies of retailers. In their model, retailers compete with each other by conducting advertised sales in order to attract consumers into the store and earn profit from other goods that consumers buy if they visit the store. They assume that there is only one type of consumer, who does not know the price of a product unless it is advertised. Advertising conveys price information to consumers, and consumers (correctly) believe that any product whose price is not advertised will yield zero surplus, i.e., retailers charge consumers their reservation values for all non-advertised products. Based on this expectation, a consumer's decision on which store to visit is based on the surplus derived from the purchase of an assortment of goods. Lal and Matutes show that one of the two equilibria results in both firms advertising the same good, and for a wide range of parameters the advertised good is sold below marginal cost.

Since the model is static, Lal and Matutes do not explain why the goods chosen to be advertised change weekly. Nor does the model provide any predictions for the dynamics of retail pricing. The model is constructed under a simple setting where retailers only sell two products, with one more popular than the other. A typical supermarket carries thousands of products, and offers a bundle of goods on sale each week. It is reasonable that retailers differentiate themselves from each other by advertising different items each period and promoting a product at different periods of time. Such strategies can prevent consumers from learning from experience. Hosken and Reiffen (2001, 2004b) extend the analysis of Lal and Matutes (1994) to a multiproduct setting. They predict that there should be considerable variation in the frequency and magnitude of sales across products in a dynamic framework.

Both Varian (1980) and Lal and Matutes (1994) show that retailers have incentives to cut retail price despite that there is no changes in costs or demand. Therefore, both theories have offered explanations for a weak relationship between retail price variation and changes in costs. On the other hand, empirical studies, such as Warner and Barsky (1995), MacDonald (2000), CKR (2003), and Hosken and Reiffen (2004b), have found that retail prices fall in periods of high demand. These findings are not consistent with the models of perfect competition or standard oligopoly (e.g., Cournot or Bertrand), which predict that firms do not change or raise prices given a positive demand shock.

Although Varian did not examine how retailers' pricing regime changes in response to a demand shock, his model implies that retailers' motivation to hold sales and the mixed strategies sustains during the high demand period. Nevertheless, under a single-product framework, the model offers no indication for how the probability of holding sales changes if demand increases. Lal and Matutes (1994) predict that retailers are likely to have “popular” products that have higher demand on sale, in order to compete for consumers’ store patronage. Therefore, the model implies that a product is more likely to be on sale during its peak demand periods.

Furthermore, Warner and Barsky (1995) explain the countercyclical price movement as the result of economies of scale in consumer search. Consumers engage in more searching and traveling between stores during peak demand periods, such as Thanksgiving and Christmas holidays, than at the other times. Consumers’ demands, thus, are more price elastic when the overall demand is high. Consequently, retailers lower prices when the overall demand is high.

One distinction between the explanations by Lal and Matutes and by Warner and Barsky is that Warner and Barsky predict that, holding other factors constant, retail prices fall during the aggregate demand peaks, but not during the idiosyncratic demand peaks. However, according to Lal and Matutes, retailers are more likely to put a product on sale during its high demand periods, even though its idiosyncratic demand peaks do not coincide with the aggregate demand peaks during holidays. Secondly, Lal and Matutes suggest that retailers put a product on sale under its ordinary demand condition as long as it is among the list of the “popular” products. In contrast, Warner and Barsky do not offer an explanation for retailers’ frequent sales behavior. The model implies that retailers have no motivation to reduce retail prices or retail markups, when the aggregate consumer demand is low.

CKR (2003) analyze the countercyclical price movement over demand cycles by using retailer scanner data on twenty nine categories of grocery products sold at 100 stores of the Dominick’s Finer Foods retail chain in Chicago metropolitan area between

1989 and 1996. Their findings support the prediction by Lal and Matutes that retailers compete with each other by advertising sales for products with high demand and, therefore, retail prices are lower during demand peaks. Our study is different from CKR (2003) in terms of analyzing the effects of demand shocks on retailer pricing behavior in at least three ways. First, CKR study manufactured grocery products at retail stores of one retail chain in the Chicago area, while this study focuses on avocados, a perishable produce, sold at a wide range of retail chains in a broad set of market areas. Second, in addition to examining retail prices and margins, we also estimate a model for retailers' decisions on temporary price reductions. Third, we look into retailer pricing behavior in response to both seasonal demand shocks and the demand shock generated by the industry's promotions, whereas CKR focus on the effects of seasonal demand cycles.

Examining how retailers set price in response to positive demand shocks is important to evaluating the industry's promotion programs. Consumer advertising programs, such as media advertisements, have been widely utilized to increase demand for a product. Retailers, according to Warner and Barsky, do not reduce retail prices or markups during the idiosyncratic demand peaks generated by product-specific promotion programs. However, Lal and Matutes predict that retailers will conduct sales for a product if a promotion campaign can successfully increase its demand.

III. Avocado Production, Trade, and Promotion

California avocados, with average annual sales of $346 million from 2001 to 2003, ranked fourth in farm value of production among California fruit crops (following grapes, strawberries, and oranges) and 16th among all California crop and livestock commodities (*California Agricultural Statistics*, 2003). California produces 90 percent of the annual

U.S. avocado crop, with Florida accounting for the remainder (*Noncitrus Fruits and Nuts Summary*, 1997-2004).[4]

This study focuses on the Hass avocado variety, which is only produced in California in the U.S. The Hass variety accounts for about 92 percent of California avocado production and 97 percent of sales revenue for the five varieties with commercial production since 2001. Although produced throughout the year, production of California Hass avocados tends to be seasonal, with very low production during November and December, increasing to May and remaining high through September, and then decreasing through the end of October (figure 1).

Due to the seasonal pattern of California avocado production, avocado supply in the U.S. is supplemented by imports. The Hass variety has comprised 90 percent of total U.S. avocado imports since 2001. Chile is the largest avocado exporter to the U.S., followed by Mexico. The two countries account for over 90 percent of total avocado imports and nearly all of the Hass imports. As shown in figure 1, avocado imports to the U.S. reveal a clear seasonal pattern that is counter to the seasonal pattern of the California avocado production. Imports of Chilean Hass avocados (CHA) occur throughout the year. CHA imports typically begin to increase in August, with the highest volumes occurring during September through December, and then decrease through March and remain very low until August.

Trade barriers for Hass avocados from Mexico have been in place due to stated concerns about invasive pests and diseases. MHA could only enter Alaska in the U.S. before November 1997. There has been a progressive elimination of import restrictions on MHA since then. In November 1997, MHA were allowed to enter the continental U.S.

[4] Hawaii accounts for less than 0.5 percent of the U.S avocado annual production.

for the first time. Nineteen states and Washington D.C. allowed MHA imports during November—February each year, beginning in November 1997. Seasonal MHA imports were intended originally to complement the domestic supply and fill the natural void caused by lower domestic production in the late fall and winter, while minimizing risks of introducing pests and diseases from Mexico. A second trade liberalization occurred in November 2001 when MHA were allowed to enter twelve additional states, and the import season was expanded to a six-month period, from October 15 to April 15 each year. Finally, beginning on January 31, 2005, MHA imports were allowed to enter all U.S. states except California and Florida year around. California and Florida are slated to open their markets to MHA after January 31, 2007.

Avocado imports increased dramatically after the fourth quarter in 1998, while the domestic production fluctuated during this period (figure 1). The average annual growth rates were 35 percent for total avocado imports, 37 percent for Chilean avocado imports, and 55 percent for Mexican avocado imports during 1997—2004. The share of Chilean avocado imports remained stable, 66 percent on average during 1996—2004. The share of avocado imports emanating from Mexico increased from 7 percent in 1996 to 27 percent in 2004 accompanied by decreases in imports from other exporters, such as the Dominican Republic. Meanwhile avocado consumption has increased steadily during the same period, with an average annual growth rate of 10 percent. The share of domestic consumption supplied by California declined from 82 percent in 1996 to 55 percent in 2004.

Promotions are a prospectively important tool to help the California avocado industry remain competitive in the face of increasing import competition. The industry expended $10 million annually during 2002—2004 on its combined marketing programs conducted through the auspices of the California Avocado Commission (CAC). Specific marketing efforts have taken a variety of forms, including consumer advertising, merchandising, promotions directed to food service, and public relations. Consumer advertising received the greatest percentage of marketing program funds, averaging 50 percent of total marketing program expenditure during this period.

The CAC's advertising programs are conducted in eleven or twelve selected markets each year,[5] and are broken down into three categories by media type: radio advertising, outdoor displays, and magazine advertising.[6] Radio advertising received on average 61 percent of all advertising dollars during 2002—2004. Radio promotions are conducted four times for three-week periods between February and mid-July each year. Outdoor promotions are held during the intervals between radio promotions in all the selected markets except Atlanta, and involve displays of billboards and posters. Outdoor displays accounted for 21 percent of the advertising expenditure for the same period. Magazine advertising has taken place only in Atlanta, which is considered as a developing market by the CAC. Information cards and/or flyers are placed in some issues of some magazines sold in Atlanta.

The only prior evaluation of avocado industry advertising programs is the work of Carman and Craft (1998), who analyze the CAC's promotion programs using aggregate annual data from 1961-95. This study indicates that avocado advertising was effective on balance, yielding an average return of $7 per $1 expended on advertising. However, it does not provide evidence on demand responses to different promotion activities at the

[5] The selected markets for the CAC's promotion programs are Los Angeles, San Diego, San Francisco, Sacramento, Phoenix, Dallas, San Antonio, Houston, Denver, Portland, Seattle, and Atlanta. The CAC stopped its promotions in Denver after 2002, and began its promotions in Phoenix and Seattle in 2001.

[6] Eighty-five percent of consumer advertising funds were spent on radio advertising, outdoor displays, and magazine advertising during 2002—2004. The rest were used to cover administration costs (8.6%), and were spent on other programs (6.4%), such as coupon program.

disaggregated level. In addition, little is known about how retailers' pricing strategies interact with and modify the effectiveness of this and other industry promotion programs. The data set available for this study provides us an unprecedented opportunity to assess these issues.

IV. The Data

We were able to assemble a unique and comprehensive dataset through the cooperation of the CAC and its marketing agent—Fusion Marketing. The specific data sources include weekly retailer scanner data provided by Information Resources Inc. (IRI) for 82 major U.S. retail accounts across 38 markets for avocados from November 2001 to October 2004. A "retail account" refers to a particular market-retail chain combination, e.g., Retailer 1 in Chicago. Data for 46 retail chains are included. We are not able to reveal the names of retail chains due to the agreement with IRI. The weekly data include volume and dollar sales, and retail prices. We focus on large and small sizes of Hass avocados, which were carried by most of the retail accounts and accounted for over 90 percent of the total category sales. The marketing year for avocados, which runs from Mid-October through Mid-October in the following calendar year, is used in our analysis instead of calendar year.

Second, we were provided access to information on the media types, geographic locations, and the timing of the advertising programs conducted by the CAC during the study period. Third, the CAC provided weekly shipment data, including shipping-point prices and shipment volumes of Hass avocados from California to each of the 38 destination markets during the study period. The weekly shipping-point prices are the average weekly prices charged by shippers for shipments to each of the destination markets. These prices exceed the farm-gate prices by amounts that reflect shippers' inventory and transactions costs and provide a better reflection of what retailers in each destination market actually paid than do the farm-gate prices. Fourth, we obtained data on monthly volumes and values of total Hass imports to the U.S., and the Hass imports from Chile and Mexico to the U.S. from the United States International Trade Commission (USITC).

V. Retailers' Pricing Behavior for Hass Avocados

California avocados were shipped to 65 destination markets in the U.S. during 2002—2004 marketing year. The top five, ten, and twenty markets accounted for 46, 68, and 88 percent of the total sales of California Hass avocados respectively during this period. Los Angeles was the largest destination for California Hass avocados during this period, with a 21 percent share of shipments. San Francisco, Dallas, San Antonio, Sacramento, and Houston each had a market share for shipments between five and seven percent over this period. The rest of the destination markets each had a less than 5 percent market share for shipments. In this section, we present a descriptive analysis of retailers' pricing behavior for Hass avocados for some retail markets to illustrate the range of pricing practices by the retail accounts in the sample.

Table 1 reports means, standard deviations, and ranges between the 25th and 75th quartiles, and the minimum and maximum values of retail prices and shipping-point prices per unit for "large" and "small" Hass avocados in seven U.S. cities. Panel (a) shows that the shipping-point price accounted for less than half of the retail price for Hass avocados on average for all markets in the data. Statistics in panel (b) are at the retail account level, e.g., Dallas 1 means retailer 1 in Dallas. Panel (b) illustrates the evident heterogeneity of retail prices for different sizes, at different retail accounts, and in different markets. Retailers' pricing strategies were diverse in many cases in terms of (i) average price for each size, (ii) variability of price around the mean, and (iii) pricing relationships between large and small avocados. For example, the ranges of means and standard deviations of price for large avocados for the retail accounts in Phoenix were from \$1.35 to \$1.85 and from 0.27 to 0.59, respectively. Several retailers (Baltimore 1, Dallas 2, Denver 3, and Seattle 2 and 3) charged similar prices for large and small avocados, while others (Los Angeles 2 and 3, Dallas 1, Denver 1, Phoenix 1 and 2, and Seattle 1 and 4) discounted small avocados sharply, and some retailers carried only large avocados (Los Angeles 4 and Baltimore 3).

However, as shown in panel (c), means and standard deviations of shipping-point prices to different destination markets were close and had negligible deviations from the averages across all markets. Therefore, shipping-point prices do not exhibit much heterogeneity across markets and, thus, do not contribute to explaining the heterogeneity across markets in retail prices.

Table 2 summarizes the results of Scheffe multiple-comparison tests of the null hypothesis of equality of means of retail prices between retailers in the same market, and Chi-square tests for the null hypothesis of equality of variances of retail prices in the same market. The test results indicate that both means and variances differ significantly for the vast majority of retail accounts and for both large and small avocados.

Table 3 reports the correlations of retail prices between retail accounts and the correlations between retail prices and shipping-point prices in six markets. The correlation coefficients further demonstrate the heterogeneity in retailers' pricing behavior and the tenuous linkage between farm and retail prices. Correlations of prices among retail chains within the same city are rarely higher than 0.5, and are negative in some cases. Although shipping-point prices for large and small avocados are highly correlated, the correlation of prices between large and small avocados within the same retail account (highlighted in gray) is typically low and sometimes even negative (e.g., retailers 4 and 5 in Dallas and retailer 2 in Phoenix), despite the fact that these prices were subject to the same shipping-point price shocks and cost shocks at the retail account level, demonstrating that cost shocks are often not an important factor in determining retail price variations.

Consider the correlations between retail prices and shipping-point prices. Avocados are a perishable fruit.[7] Based upon the limited storage period for avocados, the lagged response of retail prices to shipping-point prices should not be more than two weeks. Table 3 includes correlations between retail prices and shipping-point prices in the current period and lagged one week. Avocados are sold directly from grower-shippers to retailers, and, therefore, we might anticipate a strong link between shipping-point and retail prices. However, nearly all the correlations are below 0.5, most are below 0.2, and in some cases the correlations are negative—e.g., in Dallas, Chicago, and Phoenix. This general conclusion holds for both contemporaneous and lagged shipping-point prices.

Table 4 illustrates the patterns of variations in retail prices for Hass avocados. First, a quarterly (an annual) modal price is computed for each size of Hass avocado sold by each retail account in each quarter (year). Second, we compute the average frequencies of retail prices equal to, or larger than, or less than the quarterly (annual) modes across all retail accounts and over time for each size of Hass avocados. The

[7] Avocados can be stored less than 10 days at room temperature and less than two weeks under cooling. The CAC recommends that shippers "pre-condition" avocados to achieve a better appearance and prevent damage from chilling. Avocados can usually be stored less than 10 days after pre-conditioning.

frequencies computed by the quarterly modal prices are reported outside and to the left of the parentheses, and those computed by the annual model prices are reported in the parentheses. Retail prices stayed at the quarterly (annual) modes for 21 percent (13 percent) of time, and retail prices were below its quarterly (annual) mode for 62 (58) percent of time.

Third, we compute the average frequencies of retail prices above or below the quarterly (annual) modes by 10, or 20, or 30 percent. Retail prices were less likely to go above the quarterly (annual) modal prices by 20 or 30 percent. In contrast, retail prices were below both modal prices by 20 or 30 percent for 21 or 30 percent of the time. Finally, we construct a retail price index as the ratio of retail price over its quarterly (annual) mode. The means of the retail prices indices computed by both quarterly and annual modal prices are below one for both sizes of Hass avocados.

Consistent with findings by Hosken and Reiffen (2004a),[8] we find that there existed a "regular" price for avocados, and most deviations from the "regular" price were downward. In particular, we define that a temporary price reduction occurs if the retail price is below its quarterly modal price by 20 percent. Because the weekly data offer sufficient frequency, we use quarterly modal prices to capture seasonal changes in means of retail prices. Temporary price reductions accounted for 26 and 28 percent of quarterly variations in retail prices for small and large Hass avocados, respectively.

Figure 2 displays histograms for the retail price indices and shipping-point price indices computed by quarterly modal prices for each size of Hass avocados. The kernel density is estimated by the Epanechnidov kernel function. The density estimations fit the

[8] Hosken and Reffein (2004a) analyze retail price variations by using monthly data at the market level. Annual model prices are used to compute the percentage of observations on, or above, or below the annual modes.

histograms in lines. The shipping-point price indices are computed for the convenience of comparison. We compute a quarterly modal price for each size of Hass avocados shipped from California to each destination market in each quarter in each year. Because there exist multiple modes for shipping-point prices in many cases, we use the highest quarterly modes in such cases. The retail price indices equal to one were realized with probability mass, but the shipping-point price indices did not have any dominant value with significantly high probability. The distributions of the shipping-point price indices are symmetric compared with the distributions of the retail price indices, which are evidently asymmetric, flatter to the right of the modes than to the left.

Varian (1980) suggests that the distributions for retail prices are U-shaped in that the highest and lowest prices are charged with higher probability than intermediate prices. For grocery shopping, it is conceivable that fixed costs to acquire price information are considerable and the number of uninformed consumers is relatively large. Varian predicts that high prices will be charged a high percentage of the time in such situation.

The observed distributions of the retail price indices for Hass avocados revealed some evidence that supports Varian's predictions. The quarterly modal prices were above means with notably high frequencies, 21 percent on average. In addition, decreases in retail prices dominated variations in retail prices, since retail prices were below the quarterly modal price for 62 percent of the time. Notice that Varian focuses on retail price variations given constant costs. Hence, Varian's predictions are essentially applied to retail margins. Although the distributions of the retail price indices are obviously not U-shaped, we can not conclude that the observed price distributions are incompatible with those predicted by Varian. Nonetheless, important characteristics of retail price distributions that we have shown have presented some evidence for Varian's predictions.

In summary, our descriptive analysis of retailer pricing behavior reveals substantial heterogeneity among retailers in pricing, and provides no indication of coordination among retailers within the same market area in pricing avocados. Second, the correlations between retail prices and shipping-point prices are low, indicating that retailers' costs are not a primary factor determining the prices set at retail. Third, we also illustrate the existence of a "regular" retail price for avocados. Downward deviations from the "regular" price dominated changes in retail prices, in particular, temporary price reductions accounted for 27 percent of retail price variations. Finally, we find that retail prices distributions were distinct from the distributions of shipping-point prices. Our findings provide support for Varian's predications about retail pricing.

VI. Identification of the "Treatment Effects" of the CAC's Promotion Programs

The approach of Difference in Difference (DID) is employed to examine how retailers set prices in response to the CAC's promotions, and to evaluate the promotional effects of the CAC's advertising programs on retail sales. The DID approach has been applied broadly in studies on program and policy evaluations, such as Card's (1990) assessment of the effects of immigration on native wages and employment and Angrist and Levy's (1999) analysis of the effect of class size on student test scores. Despite substantial prior research on evaluation of promotion programs, few have utilized the DID approach. To our knowledge, the only study is Busse, Silva-Risso, and Zettelmeyer (2004), who analyze the effects of asymmetry information in the bargaining process on transaction prices under cash rebate promotions in the car industry.

We discuss the DID approach in the context of evaluating the effect of the CAC's promotion programs on retail prices following Ashenfelter and Card (1985), who evaluate the effect of job training on earnings. The DID approach is also applied to evaluate other outcome measures, such as retail margins, retailers' decisions on temporary price reductions, and retail sales. The empirical models for each of the outcomes are presented in the next section.

The fact that the CAC selected a set of markets for its promotion programs enables us to construct both treatment and control groups for the program evaluation. The DID approach estimates the counterfactual outcomes for the retail accounts in the selected markets that received the CAC's promotion programs. The DID framework for identifying the "treatment effects" of the CAC's promotions on retail prices can be presented by the following linear model:

$$p(a,t) = \delta(t) + \eta(a) + \psi D(a,t) + \nu(a,t)\,, \tag{1}$$

where $p(a,t)$ denotes the price of avocados charged by retail account a at time t. Let the pre-treatment period, $t = 0$, be the period when there was no promotion, and let the post-treatment period, $t = 1$, be the period when the CAC conducted its promotions. $D(a,t)$ denotes whether a retail account was exposed to the CAC's promotions or not. Suppose that only $p(a,t)$ and $D(a,t)$ are observed. We refer retail accounts that were exposed to the CAC's promotion programs (i.e., $D(a,1) = 1$) as the "treated", and those that were not exposed to the promotions (i.e., $D(a,1) = 0$) as the "controls". $D(a,0)$ equals zero for both the treated and controls, because there was no promotion at $t = 0$. ψ represents the "treatment effects" of the CAC's promotion programs. $\delta(t)$ denotes the time-specific component, $\eta(a)$ represents the account-specific effects, and $\nu(a,t)$ is the individual transitory error term with zero mean at both $t = 0$ and $t = 1$. The advantage of the panel data utilized in this study enables us to control idiosyncratic characteristics of individual retailers or markets by fixed effects.

The CAC did not select markets for its promotion programs randomly. The selected markets are among the top fifteen markets that have the largest market shares of avocado sales in the U.S., and did not allow MHA imports during the study period.[9] A concern usually arises about selection bias. That is, selection for promotions may be correlated with the individual transitory error term. However, the set of markets selected by the CAC for promotion has been quite stable since 1997. We believe that market selection for the CAC's promotions is affected by market-specific characteristics that do not change during the study period, and, therefore, can be controlled by fixed effects.

Under the assumption that selection for treatment is not correlated with the error term, we can obtain the difference in the expected retail prices with and without the CAC's promotions for the retail accounts in the treated and control markets as

$$
\begin{aligned}
& E[p(a,1) \mid D(a,1)=1] - E[p(a,0) \mid D(a,1)=1] \\
&= E[p(a,1) - p(a,0) \mid D(a,1)=1] \\
&= [\delta(1) - \delta(0)] + [\eta(a) - \eta(a)] + \psi[D(a,1) - D(a,0)] \\
&= \delta(1) - \delta(0) + \psi
\end{aligned}
$$

$$
\begin{aligned}
& E[p(a,1) \mid D(a,1)=0] - E[p(a,0) \mid D(a,1)=0] \\
&= E[p(a,1) - p(a,0) \mid D(a,1)=0] \\
&= [\delta(1) - \delta(0)] + [\eta(a) - \eta(a)] \\
&= \delta(1) - \delta(0)
\end{aligned}
$$

Notice that the use of a simple comparison of retail prices before and after promotions to evaluate the promotional effects is likely to be biased by temporal trends in retail prices or by factors other than the promotions that occurred during both periods. The DID approach is applied to construct a counterfactual against which to measure the

[9] An exception is Denver, where the CAC continued promoting avocados in 2002 after MHA imports were allowed to enter Colorado in November 2001, but the CAC discontinued its promotion programs in Denver after 2002.

promotional effects. Therefore, the "treatment effects" of the CAC's promotions, ψ, can be identified in the following form:

$$\psi = \{E[p(a,1) \mid D(a,1)=1] - E[p(a,0) \mid D(a,1)=1]\} \\ - \{E[p(a,1) \mid D(a,1)=0] - E[p(a,0) \mid D(a,1)=0]\}$$

The DID estimator requires a strong assumption that the average outcomes for the treated and controls would have followed parallel paths over time in the absence of the treatment. However, a complication arises in our application because shipping-point prices for avocados differ somewhat across market destinations, as table 1 documents. If retail prices at the stores in the treated markets were higher than retail prices at the stores in the control markets, it could be the result of the higher shipping-point prices in the treated markets relative to the control markets. Therefore, we incorporate the contemporaneous and lagged market-specific shipping-point prices as explanatory variables to control for the difference in shipping-point prices between the treated and control markets.

The other complication is that different markets might have different supply sources of Hass avocados other than California. Each of the markets selected for the CAC's advertising programs is in a state that did not allow MHA imports during the study period (see footnote 10). However, many markets in the control group in our data had access to MHA imports. The markets that allowed MHA imports likely had lower avocado acquisition costs during the months that MHA were available.[10] The shipping-

[10] To get a sense of the price difference between domestic and imported avocados, we calculated the per lb. costs of avocados imported from Chile and Mexico as the landed duty-paid values of the imports divided by import volumes. This measure includes essentially all costs incurred in getting the imported product across the border and is comparable to a per lb. shipping-point price from California. The following are the summary statistics for mean price/lb. over our November 2001—October 2004 sample period: Mexican imports—\$1.0061 (s.d. = 0.065), Chilean imports—\$1.0781 (s.d. = 0.0210), California—\$1.1668 (s.d. = 0.2453). Thus, Mexican (Chilean) imported avocados were about \$0.17/lb. (\$0.09/lb.) cheaper on average relative to California avocados.

point price series summarized in table 1 pertains only to California Hass avocados. Therefore, retail prices in the treated markets could be higher than retail prices in the control markets during some periods of the CAC's promotions because of relatively higher avocado acquisition costs in the treated markets.

We tackle this problem in two ways. First, we construct two different control groups. One control group includes markets that did not have access to MHA imports, and the other includes both markets that allowed and did not allow MHA imports. Second, we incorporate import volumes of MHA into the model when the control group includes both markets with and without access to MHA imports.

Examining how retailers respond to changes in availability of imported avocados is also important in its own right. In addition to MHA imports, avocados could be imported without trade barriers from Chile. Therefore, import volumes of Chilean Hass avocado (CHA) are also incorporated in the model. CHA imports follow a clear seasonal pattern that basically is counter to the seasonal pattern of Californian production, as shown in figure 1. Because prices of imported avocados are lower on average than the California shipping-point prices (see footnote 11), retailers who had access to MHA and/or CHA imports should have had lower acquisition costs during that period, and, hence, lower retail prices during the import season of MHA, and when CHA imports are higher, to the extent these cost savings are passed forward to consumers. The failure of retail prices to adjust to the lower acquisition cost of imported avocados would be an indication that retailers were able to obtain larger margins during the import seasons and, hence, that retailers, and not consumers, were a major beneficiary of the benefits from free trade.

The DID model for retail prices takes the following form after adding the shipping-point prices of California avocados and the Hass avocado imports from Mexico and Chile as covariates:

(2) $$p(a,t) = \delta(t) + \eta(a) + \psi D(a,t) + \theta w(a,t) + \lambda impMH(a,t) + \vartheta impCH(t) + v(a,t),$$

where *w(a,t)* denotes the California shipping-point price at time *t* in the market where the retail account *a* is located; *impMH(a,t)* represents MHA import volumes that are relevant to retail accounts in the states that allowed MHA imports at time *t*; and *impCH(t)* are import volumes of CHA at time *t* that are common to all the markets. In this generalized model, ψ is no longer the only term that accounts for the difference in the expected retail prices with and without promotions, and between accounts in the selected markets and control markets. However, ψ can still be identified as the "treatment effect" of the CAC's promotion programs on retail prices. That is,

$$\begin{aligned} & \{E[p(a,1) \mid D(a,1)=1] - E[p(a,0) \mid D(a,1)=1]\} \\ & - \{E[p(a,1) \mid D(a,1)=0] - E[p(a,0) \mid D(a,1)=0]\} \\ = \;& \psi \\ & + \theta\{[w(a,1) - w(a,0) \mid D(a,1)=1] - [w(a,1) - w(a,0) \mid D(a,1)=0]\} \\ & + \lambda[impMH(a,1) - impMH(a,0) \mid D(a,1)=0] \end{aligned}$$

The above framework is applied to evaluate three types of the CAC's promotions—radio, outdoor, and magazine advertising programs. However, the promotional effects of magazine advertisements might not be clearly identified. The DID approach requires unambiguous recognition of the periods with and without promotions. However, the timing that people are exposed to magazine advertisements is highly uncertain. For example, people could purchase an issue of a monthly magazine at any time of the month, and read it at any time after that month. In any event, magazine advertisements are of minor importance to our analysis, given that they were conducted only in Atlanta.

In contrast, the promotional effects of both radio and outdoor programs can be identified under the DID framework. People could either be exposed to an advertisement directly at the same time, or obtain the information about the advertisement indirectly through other people. Since each radio or outdoor promotion lasted a fair amount of time, three or four weeks respectively, we expect that both radio and outdoor advertising programs generated promotional effects, if any, mostly during the promotion periods. A concern still rises about identifying possibly lagged effects of both radio and outdoor promotions. Because radio and outdoor promotions followed each other consecutively, the promotional coefficient of radio advertising could also pick up the lagged effects of the preceding outdoor promotions, and vice versa. The data give us no good way to discriminate between these possibilities, but, notably, if the primary focus is the overall effectiveness of the CAC's synchronized radio-and-outdoor-media campaign, separating the impacts of the individual components is unimportant.

VII. The Empirical Models and Hypothesis Tests

We investigate retailer pricing behavior for avocados, and evaluate the effects of the CAC's promotion programs on both retail sales and retail pricing. In particular, three empirical models are estimated to examine retailers' pricing strategies: a model of retail prices, a model of the farm-retail price spread, and a model for retailers' decisions on temporary price reductions. In the following, we present empirical models for retailer pricing behavior and retail sales along with discussions on variable selection, estimation methods, and hypothesis tests.

A Retail Pricing Model

A retail pricing model is applied to capture retail price movements in response to changes in cost and demand factors. Based upon equation (2), the retail pricing model is specified in the following form:

$$
\begin{aligned}
p_{a,s,t} = {} & \alpha + \alpha_t + \alpha_{a,s} \\
& + [\psi_1 Radio_t + \psi_2 Radio_{m,t} + \psi_3 Outdoor_t + \psi_4 Outdoor_{m,t} + \psi_5 Magazine_{m,t}] \\
& + [\theta_0 w_{m,s,t} + \theta_1 w_{m,s,t-1}] \\
& + [\lambda_1 Season_t + \lambda_2 impMH_{m,t} + \lambda_3 impMH_{m,t-1}] + [\lambda_4 impCH_t + \lambda_5 impCH_{t-1}] \\
& + \varepsilon_{a,s,t}
\end{aligned}
\quad , \tag{3}
$$

where $p_{a,s,t}$ is the retail price measured by \$/unit at retail account a for size s (s = {large, small}) in week t. α is the constant term. α_t represents time-related control variables, which account for price variation over (i) marketing years, (ii) months, and (iii) holidays or special events. A marketing year runs from Mid-October to Mid-October the next calendar year. Fixed effects, $\alpha_{a,s}$, are utilized for particular account-size combinations to control for heterogeneity in retailer pricing behavior.

The set of terms in the first brackets measure the impacts of the CAC's promotion programs. $Radio_t$ and $Outdoor_t$ are set equal to one if the CAC was operating a radio or outdoor advertising program in week t. These two variables and the time-related control variables, α_t, account for shocks common to all markets during the weeks of the CAC's radio and outdoor advertising programs. Magazine promotions were conducted only in Atlanta generally on a monthly basis. Therefore, monthly dummies can control the common shocks in all markets during the CAC's magazine promotions. $Radio_{m,t}$, $Outdoor_{m,t}$, and $Magazine_{m,t}$ are the "treatment on the treated" variables, which are set equal to one if the CAC was running a radio, outdoor, or magazine promotion program in market m in week t. ψ_2, ψ_4, and ψ_5 are the coefficients to be estimated that represent the “treatment effects” of the CAC’s radio, outdoor and magazine advertising programs on retail prices, respectively.

$w_{m,s,t}$ and $w_{m,s,t-1}$ in the second set of brackets are the shipping-point prices measured by \$/unit for size *s* avocados shipped from California to market *m* in week *t* and *t*-1. The shipping-point price and its one-week lag account for the impact of contemporaneous and lagged cost-side shocks on retailers’ prices. A two-week period should represent a sufficient time period for changes in the shipping-point price for this highly perishable commodity to reflect fully in retailers’ acquisition costs (see footnote 8).

The third and fourth sets of brackets contain terms for MHA and CHA imports, respectively. $Season_t$ captures the common seasonal shocks for all the markets during the period when MHA imports were available, and it is set equal to one if MHA imports were allowed in week *t*. The variables $impMH_{m,t}$ and $impMH_{m,t-1}$ are MHA import volumes in 1,000,000 pounds in the current month and previous month, respectively. The import volumes of MHA are the total MHA imports to the U.S., but not market specific. The subscript *m* only indicates whether import volumes of MHA are relevant to market *m* that allowed MHA imports in week t. $impMH_{m,t}$ and $impMH_{m,t-1}$, therefore, represent the “treatment on the treated”. The variables $impCH_t$, and $impCH_{t-1}$ in the fourth set of brackets have the same interpretation but apply to import volumes of CHA, which are relevant to all markets. All the import volumes are on a monthly basis. They represent the import volumes of MHA or CHA available in the month in which week *t* is located. Because the storage life expectancy is less than two weeks (see footnote 8), the lagged import volumes were constructed so that import volumes in the last month are only relevant to the time prior to the middle of the current month.

The αs, ψs, θs, and λs are the parameters to be estimated. The error term, $\varepsilon_{a,s,t}$, is specified as

$$\begin{aligned}
&\varepsilon_{a,s,t} \sim N(0,\Omega)\\
&\mathrm{Var}(\varepsilon_{a,s,t}) = \delta^2_{a,s}\\
&\mathrm{Cov}(\varepsilon_{a,s,t},\varepsilon_{-a,-s,t}) \neq 0\\
&\varepsilon_{a,s,t} = \rho_{a,s}\varepsilon_{a,s,t-1} + \upsilon_{a,s,t}
\end{aligned}$$

The error term is assumed to have a normal distribution with zero mean and heteroskedastic variances for each of the account-size combinations. Second, the errors are assumed to be contemporaneously correlated between any account-size combinations. Furthermore, the error term is also assumed to follow an AR(1) process, and different autocorrelation parameters are allowed for different account-size combinations. $v_{a,s,t}$ is white noise. The model is estimated by the Prais-Winsten method, which utilizes a feasible generalized least squares estimation procedure conditioning on the assumed error structure.

A model of the farm-retail price spreads

The retail pricing model, however, cannot directly reflect how retail markups change over demand shocks. Therefore, we construct the farm-retail price spread as an approximation to the retail margin, and estimate a model of the farm-retail price spread. The dependent variable is the farm-retail price spread in $/unit for size *s* avocados at account *a* in week *t*. It is computed as the difference between retail price for size *s* avocados at retail account *a* in week *t* and the shipping-point price for size *s* avocados shipped from California to market *m* in week *t*.

There were cases when California Hass avocados were not shipped to some market during some period. If a market was not supplied by California for one or two weeks, we use the average of shipping-point prices of the preceding and following weeks when the shipping-point prices were available. If a market was not supplied by California for more than two weeks, we use shipping-point prices in a market located closest or the average of shipping-point prices in several markets located close. In either case, the proxy shipping-point price is the shadow price of California Hass avocados that retailers in the market utilized to make their procurement decisions.

The model includes all explanatory variables in the retail pricing model with exclusion of shipping-point prices. Furthermore, we include shipment volumes as an explanatory variable, which are shipments in 1,000,000 units for size *s* avocados shipped from California to market *m* in week *t*. The variable is included to indicate whether retailers are able to bid down shipping-point prices for avocados as a consequence of large shipments.[11] The model is assumed to have the same model and error structure as the retail pricing model. It is also estimated by the Prais-Winsten method.

A model for retailers' decisions on temporary price reductions

The retail pricing model and the model of the farm-retail price spreads reflect changes in the means of retail prices and retail markups for avocados, but they do not capture the changes in variability of retail prices. As shown in Section V, temporary price reductions are a very important feature of retail pricing for avocados, and account for 27 percent of quarterly variations in retail prices for avocados. It is possible that, during promotion periods, retailers conducted sales more frequently, but sold avocados at higher prices in the weeks without sales. In such a case, although the means of retail prices and markups might not be significantly lower during promotion periods than during non-promotion

[11] This hypothesis was proposed and tested for iceberg lettuce by Sexton and Zhang (1996) and subjected to further testing by SZC (2003) for iceberg lettuce and fresh tomatoes.

periods, but the probability of conducting sales were higher during promotion periods than during non-promotion periods. Consequently, avocado sales might increase due to frequent price discounts. Therefore, we employ a discrete-choice model to estimate retailers' decisions on temporary price reductions.

We define that a temporary price reduction occurs if the retail price for size s avocados at account a in week t is 20 percent off the quarterly modal price for size s avocados at account a. The dependent variable is set to one if retail account a conducted a temporary price reduction for size s avocados in week t; otherwise, it is set to zero. Retailers' decisions on temporary price reductions are related to the same set of explanatory variables in the retail pricing model. The model is in a logit framework. The error term is assumed to follow an extreme value distribution with zero mean and heteroskedastic variances at the account-size level. Furthermore, we apply clustering at the market level, which allows errors to be correlated for any account-size combinations within the same market area.

A retail sales response model

A retail sales response model is estimated to examine seasonal demand cycles for avocados and the effectiveness of the CAC's advertising programs in terms of promoting demand at the retail level. The retail sales response model is specified in the following form:

$$
\begin{aligned}
q_{a,s,t} = {} & \gamma + \gamma_t + \gamma_{a,s} \\
& + [\beta_1 \hat{p}_{a,s,t} + \beta_2 \hat{p}_{a,s,t-1}] \\
& + [\tau_1 Radio_t + \tau_2 Radio_{m,t} + \tau_3 Outdoor_t + \tau_4 Outdoor_{m,t} + \tau_5 Magazine_{m,t}], \\
& + e_{a,s,t}
\end{aligned} \tag{4}
$$

where $q_{a,s,t}$ is the sales volume for size s avocados at retail account a in week t in 1000 units. $\hat{p}_{a,s,t}$ and $\hat{p}_{a,s,t-1}$ are the predicted retail prices for size s at account a in week t and t-1 obtained from the estimation of the retail pricing model (equation (3)). Due to the likely endogeneity between the retail prices and the error term in the sales response model, we include the predicted retail prices instead of the actual retail prices. The time-related control variables, fixed effects, and the variables for the CAC's promotion programs have the same interpretations as those included in the retail pricing model. The error term, $e_{a,s,t}$, is assumed to have the same structure as the error term in the retail pricing model. The model is estimated by a two-stage least squares procedure. At the first stage, the retail pricing model is estimated by the Prais-Winsten method, and the predicted retail prices are obtained. At the second stage, the retail sales response model is estimated by the Prais-Winsten procedure by incorporating the predicted retail prices from the first stage.

Hypothesis Tests

We are interested in testing theories about how retailers set prices in response to changes in cost and demand factors. Avocados are, in general, sold directly from grower-shippers to retailers. Hence, we expect under competitive pricing that the coefficients of the contemporaneous and lagged shipping-point prices should add up to one, as costs pass through from farm to retail. Secondly, negative and significant effects of shipping-point prices on retailers' decisions on temporary price reductions indicate that temporary price reductions can be explained by decreases in costs.

Because the imported Hass avocadoes from Chile and Mexico are cheaper than the California Hass avocadoes (see footnote 11), we expect that retail prices (retailers' decisions on temporary price reductions) are negatively (positively) correlated with the availability of MHA and import volumes of MHA and CHA imports. Furthermore, the farm-retail price spreads are computed by using shipping-point prices of California Hass avocados. Therefore, we expect that the retail markups decrease as MHA and CHA imports increase.

Failure of these cost changes to transmit quickly and fully to the retail prices indicates that retailers are pursuing a pricing strategy other than cost-based, mark-up pricing. Retailer market power in selling to consumers is a necessary condition for the pricing schemes described in Section V to develop and sustain. Varian (1980), Lal and Matutes (1994), and Hosken and Reiffen (2001, 2004b) explain non-responsive retail prices with respect to changes in costs as a consequence of retailers' sales strategies, which reflect changes in retail margins rather than changes in costs. That is, retailers cut retail prices or markups despite the changes in costs.

However, if we find that retail prices are weakly related to shipping-point prices, it may be partially explained by retailer oligopsony power in buying from grower-shippers, which is suggested by Rogers and Sexton (1994), Sexton and Zhang (1996), Calvin, Cook, *et al*. (2001), and SZC (2003). If retailers do not have market power in buying from grower-shippers, we expect that shipment volumes have no effect on the farm-retail price spreads. Sexton and Zhang (1996) and SZC (2003) suggest that retailers are able to bid down prices for perishable commodities and increase the farm-retail price spread during the periods of abundant supplies. Therefore, a positive relationship between the farm-retail price spreads and shipment volumes indicates that the determination of retail prices and margins is partially attributed to retailer oligopsony power.

Marketing research conducted by the CAC suggests that avocado demand peaks during holidays and national events, such as New Year's Day and Super Bowl Sunday. As well, avocado demand is expected to be higher during summer months due to a higher incidence of parties, barbeques, etc. According to Warner and Barsky (1995), retail prices or margins are lower when the aggregate demand is higher, such as during Thanksgiving and Christmas holidays; but retail prices or margins do not decrease when the idiosyncratic demand for avocados is higher, such as during Super Bowl Sunday and summer months. On the other hand, Lal and Matutes (1994) predict that retail prices or markups are lower, and the probability of sales is higher, during demand peaks for avocados.

Consider now the expected effects of the CAC's promotions on retail sales, retail prices and markups. If the promotions are successful, retail sales should rise, whereas unsuccessful promotions will have little impact on sales. A priori expectations for the impact of promotions on retail prices are less clear. Unsuccessful promotions should have little impact on retailer pricing behavior. Lal and Matutes' model (1994) implies that retail prices or markups should fall during the CAC's promotion periods, given that the promotions are successful in increasing demand. In contrast, Warner and Barsky's model (1995) does not predict that retailers reduce retail prices or margins as a result of the increase in avocado demand generated by the CAC's promotions. On the other hand, evidence of higher retail markups in response to CAC promotions supports a simple market power model of retail pricing, whereby retailers increase prices and margins to capture benefits from the demand expansion. Notably the behavior described in Lal and Matutes' model reinforces the effect of the CAC promotions, while behavior described by the simple market power model mitigates their effectiveness.

In reality, retailers usually arrange advertised sales before the acknowledged demand shocks. As commonly observed, store flyers that contain advertised sales are usually circulated a week before sales actually take place. For example, retailers learn from experience or perceive a higher consumption of avocados during certain periods or holidays. Retailers, according to Lal and Matutes (1994), will lower retail prices or markups correspondingly. Two implicit conditions are that (i) retailers are well informed about the demand shock, and (ii) retailers perceive the demand shock is positive. A lack of response in retail pricing to the demand shocks generated by the CAC's promotions does not necessarily imply that retailers behave competitively. It might be caused by lack of communication between the industry and retailers about the industry's advertising campaigns and the effectiveness of the advertising programs.

We can also test whether the effects of the CAC's promotion programs on retail prices and sales are different across markets by estimating the models separately to obtain the pooled promotion parameters across all of the CAC treated markets and the market-specific promotion parameters in each of the treated markets. Differences among cities in the sales response to promotions may reflect different levels of intensity of promotion by the CAC, or it may reflect markets that, for whatever reason, are more or less susceptible to avocado promotions. Such information can be valuable to CAC in tailoring its programs.

VIII. The Results

Estimation results for the models of retailer pricing behavior and the retail sales response model are reported in table 5—10. All the models are estimated by using two control groups. One control group only includes markets without MHA imports, and the other includes markets with and without MHA imports. We obtained similar estimation results for all models by using either control group. In this section, we only report the results for estimations using the larger control group.

The base models, which pool retail accounts, large and small avocados, and all time periods, contain 19,072 observations. That is 124 account-size combinations with 140-157 weeks for each account-size combination. The account-size fixed effects are omitted for parsimony of presentation. The base models explain about 2/3 of the variation observed in retail prices (R^2 = 0.69), about 2/5 of the variation observed in the farm-retail price spreads (R^2 = 0.42), and nearly 3/4 of the variation observed in retail sales (R^2 = 0.72). The Pseudo-R^2 for the model of temporary price reductions is 0.1.[12] In the following, we present the estimation results by groups of explanatory variables rather than by models.

Shipping-point prices and shipment volumes

Hass avocados were sold for $1.2 per unit on average at grocery stores. The estimated average farm-retail spread ($0.78 per unit) accounted for 65 percent of the estimated average retail price. The estimates are consistent with the sample means of the retail price and farm-retail price spread, which are $1.3 and $0.73 per unit, respectively.

The retail price was positively correlated with the contemporaneous shipping-point price and its one-period lag (panel (a) in table 5). Each coefficient is statistically significant in the basic model. However, the sum of the two coefficients is only 0.34, indicating that only about one third of a unit change in the shipping-point price transmits to retail within the two-week period. Carman and Sexton (2005) suggest that a 50 percent rate of price transmission is consistent with some simple models of monopoly pricing.

[12] Pseudo-R^2 is not directly comparable with the standard R^2 (Train, 2003).

The probability of temporary price reductions went up as the shipping-point price increased (panel (b) in table 5). The estimated coefficient of the contemporaneous shipping-point price is not statistically significant. Although the estimated coefficient of the lagged shipping-point price (0.18) is statistically significant, it is small in magnitude compared with other estimated coefficients. The estimates suggest that retailers' decisions on temporary price reductions are not based primarily on changes in the shipping-point price, i.e., not cost driven. Therefore, the presence of temporary price reductions is attributable to retailers' sales strategies, which reflect changes in margins rather than changes in costs. This finding is consistent with the predictions by Varian (1980), Lal and Matutues (1994), and Hosken and Reiffen (2001, 2004b).

Existence of retailer selling power is necessary for the observed retailer pricing behavior for avocados presented in both Section V and this section. However, the non-responsive retail pricing with respect to changes in costs may be partially due to retailer market power in buying from avocado grower-shippers. The estimated coefficient of shipment volumes in the model of the farm-retail price spreads indicates that the retail markup increased significantly by 4 cents per unit if the weekly shipment increased by one million units (panel (c) in table 5). The result supports the prediction by Sexton and Zhang (1996). That is, retailers were able to bid down the procurement price for avocados, and obtain a larger retail markup, when there was a large supply of avocados.

MHA and CHA imports

The estimated results regarding the effects of MHA and CHA imports are reported in table 6. The indicator variable *season* is intended to capture general shocks during the period when MHA imports are allowed. The variable has negative and significant coefficients in the models for retail prices and the farm-retail price spreads, and a positive but not significant coefficient in the model for temporary price reductions, indicating that retail prices and the farm-retail price spreads were generally lower during the months when MHA imports were permitted.[13]

MHA and CHA imports are measured in millions of lbs. The variables for MHA imports are zeros in all markets for the months when MHA were not allowed, and in all periods for the markets where MHA imports were not allowed at any time. The contemporaneous and lagged values for the volume of MHA imports thus represent the "treatment on the treated". The current value of MHA imports is associated with a positive and significant effect on price, but the lagged value has a negative and significant effect that dominates the positive contemporaneous effect, and is in addition to the effect captured by *season*. At the same time, both the current and lagged MHA imports have positive effects on the probability of holding temporary price reductions, although only the effect of the lagged value is significant and higher in magnitude. The results indicate that retailers in the markets that had assess to MHA imports had significantly lower retail prices, lower retail markups, and were more likely to hold price discounts for avocados than retailers in the markets that did not allow MHA imports during the import season.

CHA imports were available to all states in the U.S. Both current and lagged values of CHA imports have negative impacts on retail prices and price spreads, and have positive effects on temporary price reductions. The volumes of MHA and CHA are generally associated with lower retail prices, lower retail markups, and higher probability

[13] Notably, this effect may well be due to the presence of the MHA imports simply through normal functioning of the market mechanism. In response to imports of MHA in some markets, shippers would be expected to rationally reallocate some California Hass avocados to the markets not affected directly by Mexican imports, which, in turn, could cause retail prices to fall in those markets.

of temporary price reductions. Thus, we can conclude that consumers do benefit as a consequence of increasing the volume of imported avocados from Chile and Mexico.

Seasonal demand shocks

Turn now to the estimation results for the retail sales response model, which are presented in panel (d) in table 5. An average retail account sold about 65,084 units of Hass avocados for each size in one week. We find that the estimated own price elasticity of Hass avocados evaluated at the sample means is -2.38 and is highly significant, suggesting that demand for Hass avocados at the individual retailer level is quite elastic. The estimated elasticity of the lagged own price on demand is -0.26 and is not statistically significant, suggesting the absence of a consumer inventory effect whereby low prices in the prior week might cause some consumers to stock avocados, thereby decreasing demand in the next week. Such stockholding behavior is unlikely due to perishability of avocados. On the other hand, it implies that consumers primarily respond to the price tag that they see in the current week, and probably do not remember and/or rely on price information in the last week.

The estimates of time-related and seasonal variables are reported in table 7. The models reveal evidence of rising retail prices and sales for avocados, with prices and sales slightly higher in marketing year 2003 and significantly higher in marketing year 2004 than in the base 2002 marketing year.

As expected, monthly demand for avocados was highest in the summer months May through September, with June having the highest demand. A Chi-square test rejects the hypothesis of equality in the month-to-month effects (χ^2_{10}= 28.7, $\rho < 0.01$). A mild month-to-month pattern in prices is also present, and a Chi-square test for equality of the monthly price effects is strongly rejected (χ^2_{10} = 160.47, ρ < 0.01). Although retail prices in the high-demand summer months were not significantly different from other months, the farm-retail price spreads were significantly lower in May and June, and the probability of temporary price reductions was significantly higher in May, July, August and September.

We also see clear evidence of price effects for some events and holidays. Six holidays/events, Christmas/New Year, Super Bowl Sunday, Cinco de Mayo, Memorial Day, Independence Day, and Labor Day had significantly higher demands in the shopping week(s) preceding and/or during the holiday/event. [14] Among the six holidays/events associated with significantly higher avocado sales, Christmas/New Year, Super Bowl Sunday, and Cinco de Mayo are associated with significantly lower prices, lower retail margins, and higher incidence of temporary price reductions. Super Bowl Sunday had the strongest effect on sales and retail pricing among holidays/events. Although prices were significantly higher in the weeks associated with Memorial Day, retail markups were not significantly higher, and temporary price reductions were more likely to take place, but not significantly. Independence Day and Labor Day had no significant effects on retail pricing.

Thanksgiving Day and Christmas/New Year are considered national holidays when people go out for shopping. Therefore, we expect that the aggregate demand during these holidays is high, as shown in Warner and Barskey (1995) and CKR (2003). We find that retail prices and markups were significantly lower only during Christmas/New Year. However, Thanksgiving Day had significantly positive effects on retail prices and

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[14] The holiday dummy variables are constructed in the following way. If a holiday occurred on Monday, or Tuesday, or Wednesday, both the week before and the current week are considered as holiday weeks. If a holiday occurred after Wednesday, only the current week is considered as a holiday week.

markups. Therefore, the results are not consistent with the predication by Warner and Barsky (1995) that retail prices or markups fall during the periods with high aggregate consumer demand, but not during the periods with high idiosyncratic demand.

The estimation results produce some evidence in support of the hypothesis by Lal and Matutes (1994) that retail prices or retail markups are lower, and the probability of sales is higher, ceteris paribus, during high-demand periods for avocados. First, retailers were more likely to conduct temporary price reductions during almost all the summer months when demand for avocados was high. The retail price for avocados was significantly lower in May, and the retail margin was significantly lower in May and June relative to the January base. Second, the retail price and markup were significantly lower, and the probability of temporary price reductions was significantly higher during holidays and events associated with significantly higher demand for avocados, in particular Super Bowl Sunday and Cinco de Mayo, when the aggregated consumer demand was not necessarily higher.

The CAC's promotion programs

Table 8 presents the estimation results for the effects of the CAC's promotion programs. The CAC's radio and outdoor advertising campaigns were associated with significantly higher retail demands in the base model. The presence of the radio (outdoor) campaign in the treated market was associated on average with 7,058 (8,822) more units sold for each size of Hass avocados at a retail account in one week. Magazine advertising in Atlanta had a positive but mild and insignificant coefficient. Neither the radio, nor outdoor, nor magazine campaigns had a significant impact on retail price, or on retail markup on average. The retail price and markup were lower (higher) during the radio (outdoor) campaigns, but the effect was negligible and insignificant. However, retailers were more likely to hold temporary price reductions during the CAC's promotion programs, in particular, retailers tended to conduct significantly more temporary price reductions during the radio promotions. Lower retail price and markup, and more frequent temporary price reductions during the radio promotions may suggest that retailers responded more actively to the radio advertising than to the outdoor promotions.

Market-specific promotion coefficients are also estimated for the CAC's radio and outdoor campaigns. The estimation results are reported in table 9.[15] Nine of the ten selected markets were associated with higher retail sales during the radio promotions, and three of them (San Francisco, Los Angeles and Dallas) had significantly higher sales. A test for the equality of the sales responses to the radio campaigns across all the treated markets is rejected at the 95 percent level (χ_9^2=17.08, ρ = 0.048). None of the three markets with significantly higher sales during the radio promotions were associated with significantly lower retail prices or markups. Retail prices were lower in five out of ten treated markets, but only significantly lower in Atlanta, during the radio promotions. A test that the price responses to the radio promotions are jointly equal to zero in all treated markets is rejected at the 95 percent level (χ_{10}^2=19.95, ρ = 0.032). Radio promotions had no significant effects on retail markups in any of the treated markets. A test that the responses of retail margins to the radio campaigns are jointly equal to zeros in all treated markets cannot be rejected (χ_9^2=13.04, ρ = 0.221).

The estimates of the market-specific responses to the CAC's outdoor campaigns revealed a higher degree of heterogeneity than those to the radio campaigns. All of the

[15] Table 9 only reports coefficients related to the market-specific effects. Coefficients for the other variables were little changed when the estimation model was expanded to include market-specific effects for the promotion variables.

three tests for equality of the responses in sales, retail prices, and retail markups to the outdoor promotions across the treated markets are rejected. Eight out of nine markets had higher retail sales during the outdoor promotions, with four of the effects being statistically significant. The CAC's outdoor campaigns had the strongest sales effects in San Antonio, where retail prices and markups were also significantly lower during the outdoor campaigns. Notice that the radio campaigns also had the largest positive effects on sales, and negative effects on retail prices and retail markups in San Antonio, although none of them are statistically significant. Combined, the CAC's radio and outdoor campaigns had comparatively large effects on retail sales in San Antonio, San Francisco, and Los Angeles, and comparatively minor effects on retail sales in Portland and Atlanta.

Both radio and outdoor advertising programs were successful in promoting sales at the retail level in the selected markets. In general, both campaigns had little effect on retail prices and retail margins. On balance the evidence is mixed relative to the Lal and Matutes hypothesis that higher retail demands are associated with lower retail prices or retail margins, and there is no support for the market-power hypothesis that retailers would capture benefits of demand-expanding industry promotions through charging higher prices.

As noted, retailers usually make ex-ante pricing decision. Retailers, according to Lal and Matutes, reduce retail prices or retail markups only if they are well informed about the advertising campaigns, and/or they believe that the CAC's radio and outdoor promotions will effectively increase avocado demand. Therefore, the CAC's promotion programs could possibly be enhanced if the CAC improves communication with retailers about its advertising campaigns.

IX. Conclusions

Retailers are becoming the dominant players in the food chain in the U.S. and elsewhere (Calvin and Cook, *et al*., 2001). Retailer market power is a topical issue in light of the long-standing conceptual bases, a growing body of empirical evidence, the consolidation within the retail sector, and the adoption of contracting and other emerging trade practices between retailers and the upstream suppliers.

Using a unique micro dataset, we have examined retailer pricing behavior for avocados to uncover its important characteristics and to examine the relationship between retail pricing and the underlying demand and cost factors. The study also provides evidence regarding the effectiveness of the CAC's promotion policies, in view of retailers' pricing behavior for avocados. Although the analysis focuses on avocados, the results shed some light on understanding retailer market power and retail pricing issues, and the findings apply broadly to other grocery products, in particular those in the fresh produce category.

Our analysis shows that retail prices for avocados are highly dispersed both spatially and temporarily. Retailer pricing behavior for avocados revealed substantial heterogeneity and an absence of coordination among retailers within the same market area. Retail price for avocados remained at a "regular" (modal) level for 21 percent of the time quarterly and 13 percent of the time annually. Decreases in retail price from the regular price dominated retail price variations. In particular, temporary price reductions explained 27 percent of quarterly changes in retail prices. These important features of retailer pricing behavior for avocados are consistent with those for other grocery products that have been documented in empirical studies, such as Pensendorfer (2002), CKR (2003), SZC (2003), Hosken and Reiffen (2001, 2004a, 2004b), and Li and Sexton (2005).

Our findings offer some evidence to support Varian's (1980) predictions about retailer pricing behavior.

Shipping-point prices accounted for only 35 percent of retail prices for avocados on average. Retail prices for avocados are weakly correlated with shipping-point prices for avocados. In addition, less than half of a change in shipping-point price transmitted on average to retail over the two-week horizon that coincides roughly with the shelf life of a fresh avocado. Further, we show that retailers' sales strategies, reflecting decreases in retail margins other than decreases in costs, explained the observed temporary price reductions for avocados. These results are consistent with Varian (1980), Lal and Matutues (1994), and Hosken and Reiffen (2001, 2004b), who offer explanations for the lack of responses in retail prices to cost changes, and predict that retailers have incentive to reduce retail prices or conduct sales even when there is no change in costs.

Retail prices were significantly lower as a function of the amount of avocados imported from Chile and Mexico, meaning that consumers have benefited from trade liberalization for avocados. Also notable is the rather strong evidence that retail margins increased significantly as shipment volumes increased, indicating retailer oligopsony power expressed in terms of retailer being able to bid down the procurement price for avocados during periods of abundant supply. On balance, we conclude that costs are not a primary factor in determining retail prices for avocados.

Retail prices for avocados presented countercyclical movements over seasonal demand shocks. Retail prices and markups were significantly lower, and the probability of temporary price reductions was significantly higher, during some holidays, events and summer months associated with significantly higher demand for avocados, especially during Super Bowl Sunday and Cinco de Mayo. The evidence provides support for the prediction by Lal and Matutes (1994) that retailers reduce retail prices or margins during a commodity's high-demand periods.

The difference-in-difference framework enables us to isolate the impacts of California Avocado Commission (CAC) promotion programs on retail avocado sales from other exogenous forces affecting sales. The analysis demonstrates that the CAC's radio campaign and outdoor advertisements were successful in raising avocado sales in the markets where the CAC conducted its promotions.

We find little impact of the CAC's promotional campaigns on retailer pricing, however. The estimated impacts of both radio and outdoor campaigns were on average very small and not statistically significant. There is no evidence to support the hypothesis that retailers capture some or all of the demand expansion induced by CAC promotions through charging higher prices. The evidence is mixed relative to the Lal and Matutes hypothesis that higher demand for avocados is associated with lower retail prices or retail margins. However, lack of response in retail pricing to the CAC's promotions may imply that the promotional effects could be enhanced if retailers acknowledged the adverting campaigns, and were convinced that the promotions would successfully increase demand for avocados.

The impacts of the outdoor promotions on both price and sales differed significantly across the ten retail markets where the CAC focused its efforts, whereas the effects of the radio promotions were similar across the treated markets. There is also mild evidence that retailers responded to the radio promotions more actively than to the outdoor promotions by lowering retail prices and markups, and conducting sales.

References

Ashenfelter, Orley; and David Card (1985) "Using the Longitudinal Structure of Earning to Estimate the Effects of Training Programs," *Review of Economics and Statistics*, 67:648-660.

Alston, Julian; James Chalfant; Jason Christian; Erika Meng; and Nicholas Piggott (1997) "The California Table Grape Commission's Promotion Program: An Evaluation," Giannini Foundation Research Report No. 43.

Alston, Julian; Hoy Carman; James Chalfant; John Crespi; Richard Sexton; and Raymond Venner (1998) "The California Prune Board's Promotion Program: An Evaluation," Giannini Foundation Research Report No. 344.

Angrist, Joshua; and Victor Levy (1999) "Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement," *Quarterly Journal of Economics*, 114(2): 533-575.

Azzam, Azzeddine (1999) "Asymmetry and Rigidity in Farm-Retail Price Transmission," *American Journal of Agricultural Economics*, 81(3): 525-533.

Benson, Bruce; and Merle Faminow (1985) "An Alternative View of Pricing in Retail Food Markets," *American Journal of Agricultural Economics*, 67(2): 298-306.

Bliss, Christopher (1988) "A Theory of Retail Pricing," *Journal of Industrial Economics*, 36(4): 375-391.

Boatwright, Peter; Sanjay Dhar; and Peter Rossi (2004) "The Role of Retail Competition and Account Retail Strategy as Drivers of Promotional Sensitivity," *Quantitative Marketing and Economics*, 2(2): 169–190.

Busse, Meghan, Jorge Silva-Risso, Florian Zettelmeyer (2004) "$1000 Cash Back: Asymmetric Information in Auto Manufacturer Promotions," Working Paper, Hass School of Business, University of California, Berkeley.

California Agricultural Statistics 2003, California Agricultural Statistics Service, National Agricultural Statistics Service, U.S. Department of Agriculture, http://www.nass.usda.gov/ca/bul/agstat/indexcas.htm.

Card, David (1990) "The Impact of the Mariel Boatlift on the Miami Labor Market," *Industrial and Labor Relations Review*, 44: 245-257.

Carman, Hoy F. and R. Kim Craft (1998) "An Economic Evaluation of California Avocado Industry Marketing Programs, 1961-1985," Giannini Foundation Research Report No. 345.

Carman, Hoy F. and Richard J. Sexton (2005) "Supermarket Fluid Milk Pricing Practices in the Western United States," *Agribusiness* 21, in press.

Chevalier, Judith; Anil Kashyap; and Peter Rossi (2003) "Why Don't Prices Rise During Periods of Peak Demand? Evidence from Scanner Data," *American Economics Review*, 93(1): 15-37.

Connor, John (1999) "Evolving Research on Price Competition in the Grocery Retailing Industry: An Appraisal," *Agricultural and Resource Economics Review*, 28: 119-127.

Copper, Douglas (2003) "Findings from the Competition Commission's Inquiry into Supermarkets," *Journal of Agricultural Economics*, 54(1): 127-143.

Cotterill, Ronald (1993) ed. *Competitive strategy Analysis in the Food System*, Westview Press. Boulder, CO.

Dobson, Paul; Michael Waterson; and Stephen Davies (2003) "The Patterns and Implications of Increasing Concentration in European Food Retailing," *Journal of Agricultural Economics*, 54(1): 111-125.

Faminow, Merle; and Bruce Benson (1985) "Spatial Economics Implications for Food Market Response to Retail Price Reporting," *Journal of Consumer Affairs*, 19: 1-19.

George, P.S. and G.A. King (1971) "Consumer Demand for Food Commodities in the United States, With Projections for 1980." Giannini Foundation Monograph No. 26.

Giulietti, Monica; and Michael Waterson (1997) "Multiproduct Firms' Pricing Behavior in the Italian Grocery Trade," *Review of Industrial Organization*, 12(5-6): 817-832.

Harris, Michael; Phil Kaufman; Steve Martinez; and Charlene Price (2002) "The U.S. Food Marketing System, 2002," Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 811.

Hosken, Daniel; and David Reiffen (2001) "Multiproduct Retailers and the Sale Phenomenon," *Agribusiness*, 17(1): 115-137.

Hosken, Daniel; and David Reiffen (2004a) "Patterns of Retail Price Variation," *The RAND Journal of Economics*, 35(1): 128-146.

Hosken, Daniel; and David Reiffen (2004b) "How Retailers Determine Which Products Should Go on Sale: Evidence from Store-Level Data," *Journal of Consumer Policy*, 27(2): 141-177.

Kaiser, Harry; Julian Alston; John Crespi; and Richard Sexton, eds. *The Economics of Commodity Programs: Lessons from California*, Peter Lang Publishing, 2005.

Kaufman, Phil (2000) “Consolidation in Food Retailing: Prospects for Consumers & Grocery Suppliers,” Economic Research Service, U.S. Department of Agriculture, *Agricultural Outlook*, August 2000.

Kaufman, Phil; Charles Handy; Edward McLaughlin; Kristen Park; Geoffrey Green (2000) “Understanding the Dynamics of Produce Markets: Consumption and Consolidation Grow,” Economic Research Service, U.S. Department of Agriculture, Agriculture Information Bulletin No. 758.

Lal, Rajiv; and Carmen Matutes (1994) “Retail Pricing and Advertising Strategies,” *Journal of Business*, 67(3): 345-370.

Lal, Rajiv; and Ram Rao (1997) “Supermarket Competition: The Case of Every Day Low Pricing,” *Marketing Science*, 16(1): 60-80.

Li, Lan, and Richard J. Sexton (2005) “Retailer Pricing Strategies for Differentiated Products: The Case of Lettuce and Bagged Salads,” Working Paper, Department of Agricultural and Resource Economics, University of California, Davis.

MacDonald, James (2000) “Demand, Information, and Competition: Why Do Food Prices Fall at Seasonal Demand Peaks?” *Journal of Industrial Economics*, 48 (1): 27-45.

Noncitrus Fruits and Nuts Final Estimates 1997-2002, the National Agricultural Statistics Service (NASS), U.S. Department of Agriculture, Statistical Bulletin Number SB-985.

Noncitrus Fruits and Nuts 2003 Summary, the National Agricultural Statistics Service (NASS), U.S. Department of Agriculture.

Noncitrus Fruits and Nuts 2004 Preliminary Summary, the National Agricultural Statistics Service (NASS), U.S. Department of Agriculture.

Pesendorfer, Martin (2002) “Retail Sales: A Study of Pricing Behavior in Supermarkets,” *Journal of Business*, 75(1): 33-66.

Richards, Timothy; and Paul Patterson (2003) “Competition in Fresh Produce Markets: An Empirical Analysis of Marketing Channel Performance,” Economic Research Service, U.S. Department of Agriculture, Contractors and Cooperators Report No. 1.

Rogers, Richard; and Richard Sexton (1994) “Assessing the Importance of Oligopsony Power in Agricultural Markets,” *American Journal of Agricultural Economics*, 76(5): 1143-1150.

Salop, Steven (1976) “Information and Monopolistic Competition,” *American Economic Review*, 66(2): 240-245.

Salop, Steven (1977) "The Noisy Monopolist: Imperfect Information, Price Dispersion and Price Discrimination," *Review of Economic Studies*, 44(3): 393-406.

Salop, Steven; and Joseph Stiglitz (1977) "Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion," *Review of Economic Studies*, 41(3): 493-510.

Salop, Steven; and Joseph Stiglitz (1982) "The Theory of Sales: A Simple Model of Equilibrium Price Dispersion with Identical Agents," *American Economics Review*, 72(5): 1121-1130.

Sexton, Richard; and Mingxia Zhang (1996) "A Model of Price Determination for Fresh Produce with Application to California Iceberg Lettuce," *American Journal of Agricultural Economics*, 78(4): 924-934.

Sexton, Richard; Mingxia Zhang; and James Chalfant (2003) "Grocery Retailer Behavior in the Procurement and Sale of Perishable Fresh Produce Commodities," Economic Research Service, U.S. Department of Agriculture, Contractors and Cooperators Report No. 2.

Sexton, Richard; Mingxia Zhang; and James Chalfant (2005) "Grocery Retailer Behavior in Perishable Fresh Produce Procurement," *Journal of Agricultural & Food Industrial Organization*, 3(1): Article 6.

Sobel, Joel (1984) "The Timing of Sales," *Review of Economic Studies*, 51(3): 353-368.

Stiglitz, Joseph (1984) "Price Rigidities and Market Structure," *American Economic Review*, 74(2): 350-355.

Train, Kenneth (2003) *Discrete Choice Methods with Simulation*, Cambridge University Press.

Varian, Hal (1980) "A Model of Sales," *American Economic Review*, 70(4): 651-659.

Walden, Michael (1990) "Testing Implications of Spatial Economics Models: Some Evidence from Food Retailing," *Journal of Consumer Affairs*, 24(1): 24-43.

Warner, Elizabeth; and Robert Barsky (1995) "The Timing and Magnitude and Retail Store Markdowns: Evidence from Weekends and Holidays," *Quarterly Journal of Economics*, 110(2): 321-352.

Wright, J. (2001) "Von's Grocery and the Concentration-Price Relationship in Grocery Retail," *UCLA Law Review*, 48: 743-779.

Figure 1 California Avocado Production and Avocado Imports to the U.S.

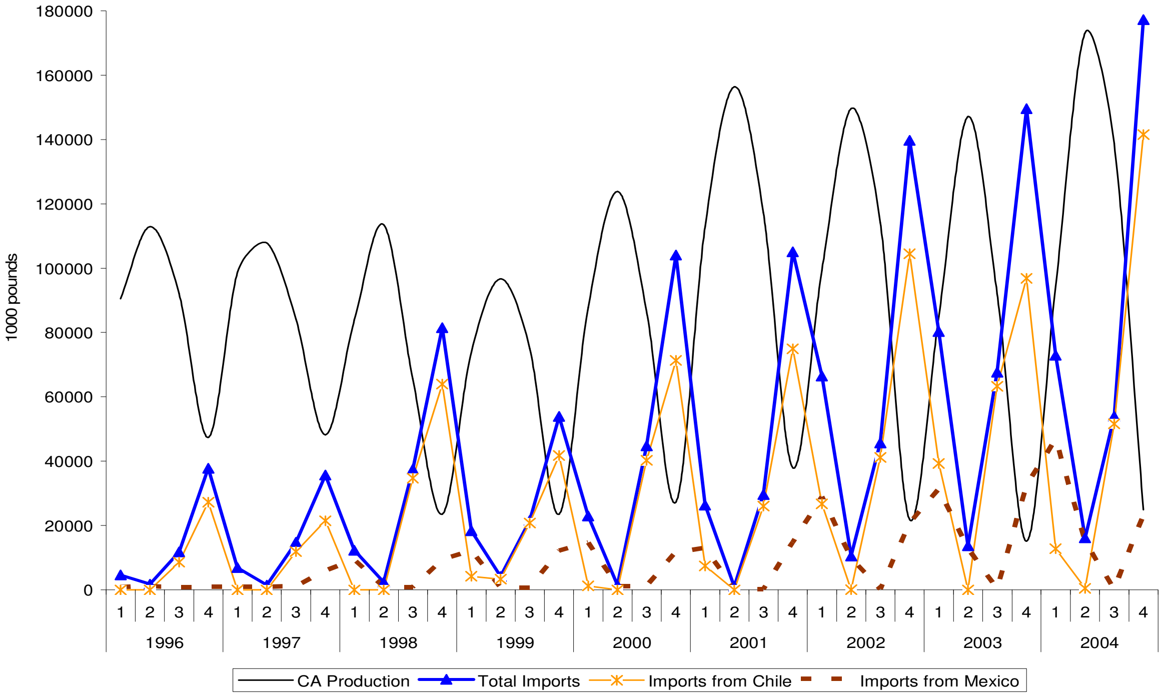
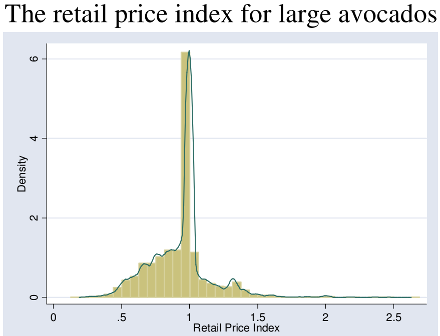


Figure 2 Histograms with Kernel Density Estimation for

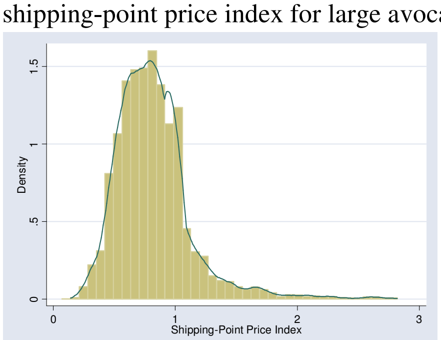
The Retail Price Index and Shipping-Point Price Index

The retail price index for large avocados

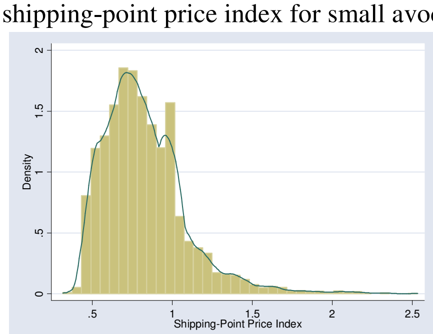


The retail price index for small avocados

The shipping-point price index for large avocados



The shipping-point price index for small avocados



Note: The Epanechnidov kernel function is utilized for kernel density estimation.

Table 1 Descriptive Statistics of Retail Prices and Shipping-Point Prices for Hass Avocados ($/unit)

			Price ranges				Price ranges	
	Mean	**Std.**	**25-75 pct.**	**min-max**	**Mean**	**Std.**	**25-75 pct.**	**Min-max**
	Panel (a) Retail Prices and Shipping-Point Prices for All Markets and Sizes							
	Retail Prices				Shipping-Point Prices			
Average (all sizes and markets)	1.30	0.43	0.55	2.55	0.57	0.19	0.27	1.35
	Panel (b) Retail Prices							
Account	Large Size				Small Size			
Baltimore 1	1.32	0.35	0.48	1.34	1.31	0.36	0.50	1.38
Baltimore 2	1.56	0.32	0.49	1.87	1.36	0.15	0.20	0.50
Baltimore 3	1.65	0.25	0.09	1.25	-	-	-	-
Chicago 1	1.64	0.27	0.40	1.13	1.24	0.39	0.88	1.24
Chicago 2	1.52	0.25	0.28	1.09	1.16	0.28	0.38	1.38
Dallas 1	1.93	0.38	0.22	1.90	1.05	0.19	0.26	0.85
Dallas 2	1.07	0.44	0.77	1.68	0.92	0.17	0.20	0.94
Dallas 3	1.44	0.25	0.22	1.43	1.09	0.55	0.91	1.75
Dallas 4	1.03	0.35	0.31	1.84	0.77	0.21	0.30	1.14
Dallas 5	1.58	0.29	0.52	1.13	1.22	0.51	1.01	1.63
Denver 1	1.95	0.29	0.18	1.48	1.11	0.26	0.28	1.39
Denver 2	1.35	0.31	0.46	1.62	1.20	0.33	0.51	1.60
Denver 3	1.61	0.40	0.64	2.36	1.48	0.39	0.18	1.86
Los Angeles 1	1.70	0.48	0.58	2.48	1.14	0.34	0.44	2.02
Los Angeles 2	1.33	0.33	0.28	1.64	0.50	0.16	0.19	0.88
Los Angeles 3	1.87	0.22	0.18	1.30	0.68	0.22	0.42	1.18
Los Angeles 4	1.33	0.27	0.43	1.25	-	-	-	-
Los Angeles 5	1.66	0.36	0.61	1.51	1.16	0.28	0.50	1.12
Phoenix 1	1.67	0.32	0.49	1.40	0.99	0.20	0.20	1.08
Phoenix 2	1.35	0.59	0.69	2.18	0.68	0.26	0.28	1.75
Phoenix 3	1.34	0.27	0.39	1.33	0.96	0.32	0.52	1.12
Phoenix 4	1.85	0.50	0.75	2.06	1.07	0.23	0.09	1.33
Seattle 1	1.96	0.32	0.15	1.92	1.10	0.26	0.31	1.42
Seattle 2	1.58	0.43	0.82	1.90	1.42	0.39	0.59	1.36
Seattle 3	1.95	0.25	0.10	2.01	1.93	0.28	0.13	1.47
Seattle 4	1.84	0.28	0.31	1.44	1.22	0.39	0.42	1.26
Average (all markets)	1.48	0.36	0.57	2.50	1.11	0.40	0.62	2.28
	Panel (c) Shipping-Point Prices							
Market	Large Size				Small Size			
Baltimore	0.69	0.15	0.17	0.75	0.42	0.12	0.13	0.70
Chicago	0.70	0.15	0.14	0.75	0.45	0.12	0.11	0.81
Dallas	0.71	0.16	0.17	0.81	0.36	0.12	0.08	0.77
Denver	0.69	0.15	0.16	0.67	0.42	0.09	0.11	0.49
Los Angeles	0.72	0.15	0.16	0.72	0.37	0.08	0.12	0.50
Phoenix	0.70	0.14	0.15	0.70	0.33	0.09	0.10	0.58
Seattle	0.78	0.16	0.21	0.86	0.42	0.08	0.09	0.44
Average (all markets)	0.71	0.15	0.17	1.16	0.43	0.11	0.14	0.90

Table 2 Summary for Test Results of Equality of Means and Variances of Retail Prices

H_0 for Hypothesis Test 1: equality of means of retail prices between retail accounts[1,2] H_0 for Hypothesis Test 2: equality of variances of retail prices within a market[1]							
		Large Size			**Small Size**		
		Test 1		Test 2	Test 1		Test 2
Market	No. of accounts	No. of tests[2]	No. of tests reject H_0	Reject H_0: Yes or No	No. of tests[2]	No. of tests reject H_0	Reject H_0: Yes or No
Atlanta	2	1	0	No	1	0	Yes
Baltimore	3	3	3	Yes	1	0	Yes
Boston	3	3	3	Yes	3	2	Yes
Buffalo[3]	2	1	1	Yes			
Charlotte	2	1	1	No	1	1	Yes
Chicago	2	1	1	Yes	1	0	No
Dallas	5	10	9	Yes	10	9	Yes
Denver	3	3	3	Yes	3	2	Yes
Houston	5	10	7	Yes	10	8	Yes
Jacksonville	3	3	3	Yes	3	2	Yes
Los Angeles	5	10	9	Yes	6	5	Yes
Miami	2	1	0	Yes	1	1	No
New York	4	6	3	Yes	6	2	Yes
Philadelphia[3]	2	1	0	Yes			
Phoenix	4	10	9	Yes	6	5	Yes
Portland	3	3	3	Yes	1	1	Yes
Richmond/Norfolk	2	1	1	Yes	1	1	Yes
Salt Lake City	2	1	0	Yes	1	1	Yes
San Antonio	2	1	1	No	1	1	Yes
San Francisco	6	15	12	Yes	15	12	Yes
Seattle	4	6	5	Yes	6	6	Yes
South Carolina	3	3	2	Yes	6	5	Yes
Tampa	3	3	1	Yes	3	3	Yes
Tennessee	2	1	1	Yes	1	1	Yes
Total	74	98	78	21 (Yes) 3 (No)	87	68	20 (Yes) 2 (No)

Notes:

1. Tests are relevant to markets that have more than one retail accounts in the data.
2. Tests are pairwise comparisons of retail prices between retailers in the same market area. The number of tests for a given market is n(n-1)/2, where n is the number of retailers in the market.
3. In Buffalo and Philadelphia, only one retailer in the data sold small size avocados during the study period.

Table 3 Price Correlations in Selected Markets

(a) Baltimore

	Baltimore-1-la	Baltimore-1-sm	Baltimore-2-la	Baltimore-2-sm	Baltimore-3-la
Baltimore-1-la	1.00				
Baltimore-1-sm	1.00	1.00			
Baltimore-2-la	0.65	0.65	1.00		
Baltimore-2-sm	0.28	0.25	0.11	1.00	
Baltimore-3-la	0.23	0.22	0.39	0.25	1.00
fob-la	0.26	0.26	0.06	0.56	0.22
fob-la (-1)	0.28	0.28	0.07	0.63	0.31
fob-sm	0.07	0.07	0.17	0.43	0.39
fob-sm (-1)	0.11	0.11	0.19	0.51	0.44

(b) Chicago

	Chicago-1-la	Chicago-1-sm	Chicago-2-la	Chicago-2-sm
Chicago-1-la	1.00			
Chicago-1-sm	0.52	1.00		
Chicago-2-la	0.43	0.17	1.00	
Chicago-2-sm	0.02	-0.24	0.34	1.00
fob-la	0.15	0.46	0.32	-0.04
fob-la (-1)	0.15	0.48	0.35	-0.01
fob-sm	0.13	0.40	0.29	-0.04
fob-sm (-1)	0.14	0.40	0.33	0.00

(c) Dallas

	Dallas-1-la	Dallas-1-sm	Dallas-2-la	Dallas-2-sm	Dallas-3-la	Dallas-3-sm	Dallas-4-la	Dallas-4-sm	Dallas-5-la	Dallas-5-sm
Dallas-1-la	1.00									
Dallas-1-sm	0.43	1.00								
Dallas-2-la	0.11	0.03	1.00							
Dallas-2-sm	0.35	0.30	0.50	1.00						
Dallas-3-la	0.40	0.11	0.19	0.20	1.00					
Dallas-3-sm	0.40	-0.06	0.62	0.28	0.40	1.00				
Dallas-4-la	-0.35	0.18	-0.09	-0.02	-0.20	-0.14	1.00			
Dallas-4-sm	0.37	0.17	0.33	0.46	0.26	0.31	-0.11	1.00		
Dallas-5-la	-0.02	0.19	0.22	-0.13	-0.02	0.11	0.23	0.14	1.00	
Dallas-5-sm	-0.46	0.35	0.37	0.34	-0.24	-0.10	0.19	0.03	-0.06	1.00
fob-la	0.41	0.51	-0.06	0.34	0.12	0.03	0.10	0.28	-0.08	0.35
fob-la (-1)	0.40	0.51	-0.01	0.38	0.13	0.05	0.09	0.24	-0.09	0.38
fob-sm	0.41	0.55	0.04	0.43	0.17	0.05	0.00	0.38	-0.08	0.44
fob-sm (-1)	0.39	0.56	0.04	0.45	0.20	0.08	-0.02	0.35	-0.11	0.46

(d) Denver

	Denver-1-la	Denver-1-sm	Denver-2-la	Denver-2-sm	Denver-3-la	Denver-3-sm
Denver-1-la	1.00					
Denver-1-sm	0.18	1.00				
Denver-2-la	-0.06	0.23	1.00			
Denver-2-sm	-0.11	-0.08	0.59	1.00		
Denver-3-la	0.46	0.32	0.32	0.14	1.00	
Denver-3-sm	0.65	0.48	-0.03	-0.17	0.46	1.00
fob-la	0.29	0.57	0.40	0.08	0.38	0.49
fob-la (-1)	0.33	0.58	0.42	0.08	0.38	0.52
fob-sm	0.28	0.63	0.35	0.10	0.49	0.55
fob-sm (-1)	0.30	0.66	0.42	0.09	0.50	0.56

(e) Los Angeles

	LA-1-la	LA-1-sm	LA-2-la	LA-2-sm	LA-3-la	LA-3-sm	LA-4-la	LA-5-la	LA-5-sm
LA-1-la	1.00								
LA-1-sm	0.53	1.00							
LA-2-la	0.31	0.16	1.00						
LA-2-sm	0.09	0.11	0.19	1.00					
LA-3-la	0.12	0.32	0.16	0.01	1.00				
LA-3-sm	-0.09	0.30	0.04	0.35	0.33	1.00			
LA-4-la	-0.20	0.32	0.43	0.09	0.17	-0.05	1.00		
LA-5-la	0.51	0.55	0.31	0.24	0.22	0.38	0.34	1.00	
LA-5-sm	0.31	-0.15	0.23	0.02	0.08	-0.26	0.25	0.04	1.00
fob-la	0.13	0.27	0.13	0.34	0.14	0.13	0.36	0.35	0.32
fob-la (-1)	0.16	0.29	0.15	0.33	0.17	0.15	0.34	0.35	0.31
fob-sm	0.28	0.35	0.26	0.45	0.10	0.16	0.40	0.43	0.35
fob-sm (-1)	0.28	0.38	0.27	0.48	0.12	0.18	0.34	0.44	0.33

(e) Phoenix

	Phoenix-1-la	Phoenix-1-sm	Phoenix-2-la	Phoenix-2-sm	Phoenix-3-la	Phoenix-3-sm	Phoenix-4-la	Phoenix-4-sm
Phoenix-1-la	1.00							
Phoenix-1-sm	0.43	1.00						
Phoenix-2-la	-0.44	-0.09	1.00					
Phoenix-2-sm	0.63	0.29	-0.45	1.00				
Phoenix-3-la	0.01	0.07	-0.68	0.14	1.00			
Phoenix-3-sm	0.62	0.26	-0.69	0.70	0.27	1.00		
Phoenix-4-la	0.46	0.26	-0.70	0.59	0.24	0.66	1.00	
Phoenix-4-sm	0.47	0.37	-0.34	0.63	0.03	0.70	0.46	1.00
fob-la	0.54	0.44	-0.01	0.36	0.07	0.52	0.31	0.51
fob-la (-1)	0.58	0.45	-0.05	0.38	0.04	0.54	0.34	0.51
fob-sm	0.58	0.49	-0.08	0.50	-0.05	0.53	0.33	0.55
fob-sm (-1)	0.60	0.49	-0.10	0.51	-0.07	0.55	0.33	0.57

Table 4 Variations in Retail Prices for Hass Avocados

Size of Hass avocados	# of observations	Retail Price Index Mean	Std.
Large	9342	0.92 (0.94)	0.18 (0.20)
Small	9730	0.93 (0.97)	0.22 (0.23)
	The average frequencies of retail prices		
	= mode	> mode	< mode
Large	21.71 (13.98)	15.01 (24.77)	63.28 (61.25)
Small	20.43 (12.84)	17.29 (31.58)	62.28 (55.58)
	The average frequencies of retail prices > mode, by		
	10%	20%	30%
Large	6.02 (13.37)	3.97 (9.21)	2.69 (6.70)
Small	7.42 (17.71)	5.53 (12.10)	3.62 (7.99)
	The average frequencies of retail prices < mode, by		
	10%	20%	30%
Large	33.78 (35.73)	21.82 (23.29)	14.19 (12.26)
Small	33.27 (32.66)	20.92 (21.66)	12.26 (12.44)

Note: The numbers outside and to the left of the parentheses are calculated according to annual model prices, and the numbers in the parentheses are calculated according to quarterly model prices.

Table 5: Estimation Results (I): General Estimation Results

Panel (a): The Retail Pricing Model

Dependent variable	Retail Price
Constant	1.206*** (0.110)
Shipping point price	
Shipping point price (t)	0.136*** (0.027)
Shipping point price (t-1)	0.205*** (0.027)
R^2	0.69

Panel (b): The Model for Retailers' Decisions on Temporary Price Reductions

Dependent variable	Temporary Price Reduction
Shipping point price	
Shipping point price (t)	0.893 (0.291)
Shipping point price (t-1)	0.180*** (0.059)
pseudo R^2	0.10

Panel (c): The Model of the Farm-Retail Price Spreads

Dependent variable	The Farm-Retail Price Spread
Constant	0.786*** (0.091)
Shipment volume	0.038*** (0.009)
R-squared	0.42

Panel (d) The Retail Sales Response Model

Dependent variable	Retail Sales
Constant	65.084*** (13.183)
Retail price	
Retail price (t)	-58.128*** (14.175)
Retail price (t-1)	-7.066 (9.649)
R-squared	0.72

Notes:

1. The reported estimates are estimated coefficients and the stand errors for the retail pricing model, the model of the farm-retail price spreads, and the retail sales response model. The reported estimates are estimated odds ratios and the standard errors for the model of temporary price reductions. Odds ratios represent log odds. For example, a coefficient of 1.5 implies that a one-unit change in this explanatory variable results in a 1.5-unit change in the log of the odds of holding temporary price reductions.
2. Standard errors are reported in the parentheses.
3. One, two, and three asterisks indicate statistical significance at the 90%, 95%, and 99% level, respectively.

Table 6: Estimation Results (II): Effects of Hass Imports

	Retail Price	Price Spread	Temporary Price Reduction
Control Variable			
Season	-0.041**	-0.054**	1.044
	(0.019)	(0.022)	(0.166)
Imports			
Mexican imports (t)	0.002	0.001	0.972
	(0.002)	(0.002)	(0.024)
Mexican imports (t-1)	-0.006***	-0.007***	1.060***
	(0.002)	(0.002)	(0.026)
Chilean imports (t)	-0.002**	-0.002	0.998
	(0.001)	(0.001)	(0.008)
Chilean imports (t-1)	-0.003***	-0.003**	1.038***
	(0.001)	(0.001)	(0.007)

Notes: The same as those listed in Table 5.

Table 7: Estimation Results (III): Effects of Seasonal Demand Shocks

	Retail Sales	Retail Price	Price Spread	Temporary Price Reduction
Import year				
Marketing year=2003	1.403	0.030*	-0.014	1.351***
	(1.749)	(0.018)	(0.020)	(0.142)
Marketing year=2004	5.244***	0.075***	0.082	1.081
	(1.904)	(0.019)	(0.020)	(0.169)
Month				
Feb	0.645	-0.015	0.002	1.590***
	(2.262)	(0.021)	(0.024)	(0.237)
Mar	-0.143	-0.040	-0.039	2.384***
	(2.547)	(0.025)	(0.029)	(0.432)
Apr	-0.888	-0.019	-0.034	3.492***
	(2.921)	(0.029)	(0.034)	(0.836)
May	4.623	-0.107***	-0.153***	4.594***
	(2.985)	(0.032)	(0.037)	(0.340)
June	12.330***	0.018	-0.075**	1.578
	(3.745)	(0.033)	(0.038)	(0.466)
July	8.192**	0.046	-0.019	1.997***
	(3.661)	(0.032)	(0.037)	(0.633)
August	5.266	0.042	-0.019	2.086**
	(3.251)	(0.030)	(0.034)	(0.539)
September	6.640**	0.019	-0.048	3.516***
	(2.915)	(0.030)	(0.034)	(1.008)
October	2.417	0.006	-0.093***	1.434
	(2.810)	(0.029)	(0.033)	(0.343)
November	2.869	0.014	-0.033	1.355
	(2.658)	(0.025)	(0.029)	(0.252)
December	-0.068	0.001	0.010	1.538**
	(2.184)	(0.020)	(0.023)	(0.237)
Holidays/Events				
Christmas/NY	4.347**	-0.040**	-0.041**	1.765***
	(2.010)	(0.016)	(0.019)	(0.232)
Super Bowl	15.040***	-0.093***	-0.104***	2.843***
	(2.735)	(0.018)	(0.021)	(0.522)
Cinco de Mayo	5.077*	-0.046**	-0.034	2.377***
	(2.776)	(0.023)	(0.027)	(0.452)
Easter Sunday	2.662	0.033**	0.031	1.002
	(2.031)	(0.017)	(0.020)	(0.143)
Memorial Day	6.044**	0.048**	0.017	0.770
	(2.712)	(0.022)	(0.026)	(0.134)
Independence Day	7.303***	0.010	-0.006	1.278
	(2.510)	(0.021)	(0.025)	(0.190)
Labor Day	3.536*	-0.010	0.002	0.898
	(1.976)	(0.017)	(0.020)	(0.106)
Halloween	1.531	0.012	-0.052**	0.743***
	(2.068)	(0.078)	(0.201)	(0.097)
Thanksgiving	-1.763	0.024***	0.043***	0.697***
	(1.606)	(0.008)	(0.008)	(0.109)

Notes: The same as those listed in Table 5.

Table 8: Estimation Results (IV): Effects of the CAC's Promotions

	Retail Sales	Retail Price	Price Spread	Temporary Price Reduction
Control variables				
Radio	-2.211*	-0.011	-0.001	0.787*
	(1.184)	(0.011)	(0.013)	(0.102)
Outdoor	-0.066	-0.034***	-0.023	0.834
	(1.422)	(0.013)	(0.015)	(0.105)
Promotions				
Radio	7.058***	-0.007	-0.005	1.378**
	(2.857)	(0.012)	(0.013)	(0.215)
Outdoor	8.822***	0.010	0.014	1.338
	(3.376)	(0.014)	(0.014)	(0.271)
Magazine	0.430	0.022	0.021	0.896
	(2.076)	(0.032)	(0.032)	(0.097)

Notes: The same as those listed in Table 5.

Table 9: Estimation Results (V): Effects of the CAC's Promotions (Market-Specific)

	Radio			*Outdoor*		
	Retail Sales	Retail Price	Price Spread	Retail Sales	Retail Price	Price Spread
San Francisco	13.362**	-0.033	-0.028	1.320	0.029	0.038
	(5.522)	(0.023)	(0.024)	(5.841)	(0.026)	(0.026)
Los Angeles	7.920*	0.015	0.000	4.671	0.032*	0.025
	(4.870)	(0.017)	(0.023)	(5.333)	(0.019)	(0.022)
Denver	3.960	0.043	0.054	-4.254	0.072	0.081
	(4.658)	(0.047)	(0.051)	(5.108)	(0.052)	(0.056)
Phoenix	2.501	0.034*	0.032	4.739**	0.026	0.028
	(1.934)	(0.018)	(0.020)	(2.153)	(0.020)	(0.023)
Huston	5.481	-0.003	-0.003	7.722*	-0.031	-0.036
	(3.985)	(0.017)	(0.018)	(4.567)	(0.019)	(0.020)
Dallas	5.521**	0.017	0.026	3.168	-0.008	0.000
	(2.234)	(0.019)	(0.020)	(2.365)	(0.021)	(0.022)
San Antonio	29.811	-0.021	-0.021	144.079***	- 0.100***	-0.107***
	(36.112)	(0.031)	(0.030)	(39.823)	(0.033)	(0.032)
Seattle	1.610	0.004	0.002	2.752**	0.030	0.025
	(1.011)	(0.022)	(0.022)	(1.173)	(0.024)	(0.025)
Portland	-1.395	-0.001	0.005	2.836	0.065**	0.070**
	(1.456)	(0.026)	(0.028)	(1.761)	(0.030)	(0.032)
Atlanta	0.606	-0.053**	-0.415			
	(1.856)	(0.028)	(0.029)			
Hypothesis Test 1 H_0: Promotion coefficients are equal across the treated markets. (d.f. = 9 for radio promotions; d.f. = 8 for outdoor promotions)						
Chi-squared	17.08	15.28	12.29	26	15.71	26.66
p-value	(0.048)	(0.084)	(0.198)	(0.001)	(0.047)	(0.001)
Hypothesis Test 2 H_0: Promotion coefficients are equal to zeros in all the treated markets. (d.f. = 10 for radio promotions; d.f. = 9 for outdoor promotions)						
Chi-squared	17.38	19.95	13.04	26.03	22.40	26.69
p-value	(0.067)	(0.032)	(0.221)	(0.002)	(0.008)	(0.002)

Notes: The same as those listed in Table 5.