



**AgEcon** SEARCH

RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

*No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.*

## **Countercyclical Price Movements during Periods of Peak Demand:**

### **Evidence from Grocery Retail Price for Avocados**

Lan Li

Department of Applied Economics and Management  
Cornell University

Email: [ll469@cornell.edu](mailto:ll469@cornell.edu)

Hoy F. Carman

Department of Agricultural and Resource Economics  
University of California, Davis

Email: [carman@primal.ucdavis.edu](mailto:carman@primal.ucdavis.edu)

Richard J. Sexton<sup>1</sup>

Department of Agricultural and Resource Economics  
University of California, Davis

Email: [rich@primal.ucdavis.edu](mailto:rich@primal.ucdavis.edu)

***Selected Paper 469829 prepared for presentation at the American Agricultural  
Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008.***

---

<sup>1</sup> The authors gratefully acknowledge research grants from the California Institute for the Study of Specialty Crops, the Giannini Foundation, and the California Avocado Commission (CAC). We appreciate the cooperation with the CAC for providing access to their database and kind assistance and helpful advice on compiling the data. Lan Li wishes to thank the Erasmus Mundus Scholar Program sponsored by the European Union, and Professor Wim Meeusen for his advice and Mrs. Mieke Vermeire for her kind assistance at the Department of Economics, University of Antwerp, where part of the research was undertaken.

*Copyright 2008 by Lan Li, Hoy F. Carman, and Richard J. Sexton. All rights reserved.  
Readers may make verbatim copies of this document for non-commercial purposes by any  
means, provided that this copyright notice appears on all such copies.*

## **Abstract**

Using a unique micro dataset and advanced panel models, this study examines the effects of demand shocks on grocery retail price for avocados, a key Californian fresh produce commodity. Retail prices for avocados exhibited countercyclical movements over seasonal demand shocks for avocados associated with some holidays and events. Demand for avocados is shown to be higher during some holidays/events, e.g., Christmas/New Year, Super Bowl Sunday, and Cinco de Mayo. Super Bowl Sunday and Cinco de Mayo are identified as holidays/events associated with idiosyncratic demand peaks for avocados, but not associated with high aggregate consumer demand. Retail price and margin were significantly lower during some holidays/events associated with high demand for avocados, e.g., Christmas/New Year, Super Bowl Sunday, and Cinco de Mayo. The study also shows that the increase in demand and decrease in retail price during holidays/events with demand peaks for avocados was present for both large and small sizes of avocados, and the size of demand increases and the size of price reductions were not statistically different between large and small size of avocados. Furthermore, shipping price did not change or increased slightly, and hence moved opposite from retail the price during most holidays/events with high demand for avocados.

We examine and test the predictions by four classes of theories that put forward to explaining countercyclical price movements over demand peaks. Overall, the evidence provides support for the Lal and Matutes (1994) model that retailers reduce retail prices and/or margins during a commodity's high-demand periods, but does not support alternative explanations for countercyclical price movements, such as Bernheim and Whinston (1990), Warner and Barskey (1995), or Nevo and Hatzitaskos (2006). The findings are consistent with the findings by Chevalier, Kashyap, and Rossi (2003).

The study estimates the effects of the CAC's promotion programs on retail sales, retail price, and shipping price at disaggregate level. The analysis demonstrates that the CAC's promotion programs were associated with positive retail sales. In particular, the evidence from the long-panel data suggests that the CAC's promotion programs were successful in raising avocado sales. There is no evidence that retailers charged higher prices during the CAC's promotions.

**Keywords:** retail price, retail price determination, countercyclical price movement, dynamic panel model, GMM.

# 1 Introduction

There is a growing body of evidence that retail prices fall in periods of high demand, e.g., Warner and Barsky (1995), MacDonald (2000), Chevalier, Kashyap, and Rossi (2003), and Hosken and Reiffen (2004), a result inconsistent with a model of perfect competition, or with standard models of oligopoly, such as the Bertrand or Cournot model. This leads to a fundamental question about pricing behavior at retail. That is, how and to what extent variations in retail prices are related to changes in underlying cost and demand factors, and are explained by retailers' strategic behavior?

Using a unique micro dataset and employing advanced panel models, this study examines retailer pricing behavior for avocados, a key California specialty commodity. How retail prices respond to seasonal demand shocks is of particular interest of this study. We examine seasonality of avocado demand and retailer pricing behavior for avocados during peaks of avocado demand. Demand for avocados peaks during some holidays/events, e.g., Christmas/New Year, Super Bowl Sunday, and Cinco de Mayo, according to the CAC. We examine how retail price for avocados changes during holidays/events associated with high demand for avocados. It has been found in the literature that retail prices are low during demand peaks. We examine four classes of theories that provide explanations for the countercyclical price movement over demand peaks. Next, we assess how shipping price changes during holidays/events with high demand for avocados, and whether shipping price moves differently from retail price. Finally, how retailers set price in response to demand shocks is important in the context of agricultural industries' efforts to promote and market their products. We evaluate the promotional effects of the CAC's advertising programs on retail sales, retail price, and shipping price. Holidays/events may be

referred to simply as “holidays” in the following discussion, e.g., holiday dummies and holiday effects.

The paper is organized as follows. The next section reviews theories that explain countercyclical price movement during periods of peak demand, and empirical findings. Section 3 describes the data, and section 4 presents the empirical models including a retail pricing model, a shipping price model, and a retail sales model. Hypothesis tests are discussed in section 5. The econometric model, model specification tests, and model selection are presented in section 6. Section 7 presents the results, and the last section concludes.

## **2 Literature Review**

Empirical studies, such as Warner and Barsky (1995), MacDonald (2000), Chevalier, Kashyap, and Rossi (2003), and Hosken and Reiffen (2004), 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 either do not change or raise prices given a positive demand shock.

Lal and Matutes (1994) and Hosken and Reiffen (2004) predict that retailers are likely to put “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 periods of its peak demand.

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.

Firms may engage in tacit collusion in a repeated game. Under a tacit collusion model with several firms selling a single product, Rotemberg and Saloner (1986) argue that the price collusion among firms could break down, and the price could fall during a temporary demand peak. This is because the benefit of cheating, i.e., benefit from the increased demand in the current period, outweighs the cost of being punished for defection. Bernheim and Whinston (1990) extend Rotemberg and Saloner's model to multi-product firms, and suggest that margins may be lower when aggregate seasonal demand is high, however tacit collusion should not be broken down and margins should not be lowered when idiosyncratic demands of individual products are high, holding aggregate demand fixed. The prediction by Bernheim and Whinston is observationally similar to the prediction by Warner and Barsky.

One distinction between the explanations by Lal and Matutes, and by Warner and Barsky and Bernheim and Whinston is that both Warner and Barsky, and Bernheim and Whinston 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. 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, neither Warner and Barsky nor Bernheim and Whinston offer an explanation for retailers' frequent sales behavior. The models imply that retailers have no incentive to reduce retail prices or markups, when the aggregate consumer demand is not high.

Chevalier, Kashyap, and Rossi (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 the Chicago metropolitan area between 1989 and 1996. They examine these three classes of theories, economies of scale in search (e.g., Warner and Barsky), tacit collusion (e.g., Bernheim and Whinston), and loss-leader models (e.g., Lal and Matutes). 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.

Nevo and Hatzitaskos (2006) use the same data as Chevalier, Kashyap, and Rossi to study the countercyclical price movement. Chevalier, Kashyap, and Rossi analyze weighted average price indices for aggregate products and aggregate product categories (e.g., tuna). The weights used to construct price indices are the dollar shares of individual UPC codes in an aggregate product or product category. Nevo and Hatzitaskos point out that weighted average price indices could be lower during seasonal demand peaks because the sales shares of cheaper products within a product category increase when demand is high, even though retailers do not change retail prices for individual products. This could arise as consumers shift their demand from quality and high-priced goods to cheaper ones when demand for a generally-defined product category is high.

Nevo and Hatzitaskos decompose the decrease in a weighted average price index into a substitution effect due to an increase in the share of cheaper products, and a price reduction effect due to direct decreases in retail prices of individual products. They find that for almost all the products they study the substitution effect explains a large part of the decrease, and price declines are associated with a change in demand elasticity and the relative demand for different brands. Their findings suggest that the prediction by Lal and Matutes does not explain price declines for the data they examine. Therefore, the countercyclical price movement over seasonal



demand cycles is explained by consumers' behavior instead of retailers' tactic pricing behavior.

Examining how retailers set price in response to positive demand shocks is important to evaluating an industry's promotion programs. 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. 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, little is known about how the effectiveness of these programs is facilitated or impeded by retailers' own pricing strategies. Retailers, according to Warner and Barsky, and Bernheim and Whinston, do not reduce retail prices or markups during the idiosyncratic demand peaks generated by product-specific promotions. However, Lal and Matutes predict that retailers will conduct sales for a product if a promotion campaign can successfully increase its demand. On the other hand, 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.

### **3 The Data**

A unique and comprehensive dataset was assembled through the cooperation of the California Avocado Commission (CAC) and its marketing agent—Fusion Marketing. The specific data sources include retailer scanner data on retail prices and sales for avocados, shipment data on market-specific shipping prices and shipment volumes for Californian and imported avocados, and industry promotion data on advertising plan and expenditure. Import arrival data on import volumes and prices for avocados to the U.S. were obtained from the U.S. International Trade Commission (USITC).

Retailer scanner data were acquired from the Information Resources Inc. (IRI) by the

CAC. Retailer scanner data contain weekly volume sales in units, dollar sales, and retail prices for different sizes and varieties of avocados for 90 major retail accounts across 38 retail markets in 26 states/regions the U.S. A “retail account” refers to a particular market-retail chain combination, e.g., Safeway in San Francisco. This study focuses on large and small sizes of Hass avocados that are conventionally grown, which were carried by most of the retail accounts and accounted for over 90% of the total category sales in the data. Retailer scanner data are available from November 3, 1996 to October 31, 2004. A complete data series without missing values has 418 weekly observations.

The CAC provided weekly shipment data, including shipping prices and shipment volumes of Hass avocados from California to each of the 38 retail markets during November 3, 1996 to October 31, 2004. These prices exceed the farm-gate prices by amounts that reflect shippers’ inventory and transactions costs and any margin that shippers are able to add, and provide a better reflection of what retailers in each destination market actually paid than do the farm-gate prices. Similar shipment data are available from the CAC for Chilean and Mexican avocados imported to the U.S. and shipped from various ports of entry to these 38 retail markets during August 4, 2002 to October 31, 2004. The ports of entry are not identified, but the destination markets are.

The shipment data for Mexican and Chilean avocados only include imports that are shipped by California handlers. According to the CAC, California handlers shipped over 70% of the total avocado imports to the U.S. Note that the shipments are for 38 major markets for avocados, but not for all destination markets. There are 65 shipping destination markets in total. These 38 markets account for over 90% of the market share for Californian avocados. shipments of Chilean and Mexican avocados to these 38 markets handled by California shippers accounted

for 38.51% and 43.21% of the total Chilean and Mexican avocado imports during November 2002 and October 2004. It indicates that these 38 markets represent a considerable fraction of the market for imported avocados. Shipping prices for Chilean and Mexican avocados handled by California handlers, in any case, are valid to represent shipping prices for all Mexican and Chilean avocados shipped to a retail market because California handlers managed the bulk of shipments, and the shipping market is mostly likely to be competitive.

The data on monthly volumes, values, and prices of the total avocado imports and the imports from Chile and Mexico to the U.S. during 1996-2004 are obtained from the USITC. The import values are landed duty paid values, which include all costs incurred before and at the U.S. border and exceed the CIF values. Import prices in \$/pound are calculated by dividing import volumes by landed duty paid values. The USITC data on avocado imports are not size specific. A caveat of the data is that the import data were for all varieties of avocados before July 2001 and were categorized into Hass and all other varieties after July 2001 inclusive. This study focuses on Hass avocados, and therefore the import volumes and prices on all varieties are used to approximate those for Hass avocados before July 2001. This is a reasonable approximation since Hass variety comprised most of avocado imports to the U.S., accounting for 93% of the total avocado imports during July 2001 and October 2004.

The CAC provided access to information on media types, geographic locations, timing, and expenditure of the advertising programs conducted by the CAC during 2002-2004. The media types of the CAC's promotion programs are radio advertising, outdoor displays, and magazine advertising. The CAC's advertising programs are conducted in eleven or twelve selected markets during late January or February to July each year. These eleven or twelve markets were chosen for the CAC's advertising programs for more than ten years.

Two panel datasets are constructed to match different data according to the time periods that the data are available. Econometric models may be applied to both or either dataset as appropriate. A long-panel dataset includes the following data from November 3, 1996 to October 31, 2004: (i) retailer scanner data including weekly retail prices and unit sales for large and small avocados in 90 retail accounts in 38 markets; (ii) the shipment data for Californian avocados including weekly shipping prices and volumes for large and small avocados shipped to 38 markets; and (iii) the USITC import data including monthly import prices and volumes for avocados of all sizes to the U.S.

A short-panel dataset includes the following data from August 4, 2002 to October 31, 2004: (i) the retailer scanner data; (ii) the shipment data for Californian avocados; (iii) the shipment data for Chilean and Mexican avocados including weekly shipping prices and volumes for large and small Chilean and Mexican avocados shipped to 38 markets; and (iv) promotion data including weekly advertising expenditure for each type of promotions and in each one of the nine promotion markets conducted by the CAC. There are 418 weeks and 118 weeks for the short- and long-panel data, respectively.

## **4 The Models**

This study examines the effects of seasonal demand shocks, in particular holidays and events, on retail price, retail demand, and shipping price for avocados. The most popular uses for avocados include Guacamole, salads, and sandwiches. Avocado consumption is likely to be high where the Hispanic population is high and when the weather is warm. The CAC claims “party time is avocado time.” Avocado demand is expected to be high during national holidays, regional events, or whenever people celebrate as a group. Fourteen holidays and events are chosen that are either public holidays in the U.S. or are identified by the CAC as holidays and events with high

avocado sales.<sup>2,3</sup> First, we examine seasonality of avocado demand and identify important holidays and events with significantly high avocado demand in a retail sales model. Next we examine how retail prices change during holidays and events with high avocado demand in the retail pricing model. Third, we also assess the effects of holidays and events on shipping prices for avocados in a shipping price model, and whether retail prices and shipping prices move in different ways during holidays and events associated with high demand for avocados. Twelve dummy variables for holidays and events are included in the retail sales model, the retail pricing model, and the shipping price model to estimate the effects of holidays and events on retail sales, retail prices, and shipping prices, respectively.

#### ***4.1 The retail pricing model***

A retail pricing model is estimated by both the short-panel and long-panel data. The following data are only available for the short-panel data: the data on the shipping prices for imported avocados are available after August 4, 2002, and data on industry advertising expenditure are available after 2002.

The retail pricing model estimated using the short-panel data can be specified in the following linear form:

$$\begin{aligned}
 p_{a,s,t} = & \alpha + [\rho_1 p_{a,s,t-1} + \dots + \rho_J p_{a,s,t-J}] \\
 & + [\theta_0 w_{m,s,t} + \theta_1 w_{m,s,t-1} + \theta_2 w_{m,s,t-2}] \\
 & + \varphi Ad_{m,t} \\
 & + \alpha_t + \alpha_{a,s} + \varepsilon_{a,s,t}
 \end{aligned} \tag{1}$$

---

<sup>2</sup> The fourteen holidays and events include Christmas/New Year's Day, Super Bowl Sunday, Valentine's Day/Washington's Birthday, Academy Awards, Easter, Cinco de Mayo, Mother's Day, Memorial Day, Father's Day, Independence Day, Labor Day, and Thanksgiving.

<sup>3</sup> It is reported by the CAC in 2004 that ten holidays and events produced about 42% of the total annual retail sales of avocados in the U.S., with Super Bowl Sunday and Cinco de Mayo each accounting for 10% of the annual retail sales in the U.S. Independence Day, Easter, Valentine's Day/Washington's Birthday and Memorial Day each accounts for approximately 5% of the annual avocado retail sales in the U.S. Significant sales are also registered during New Year's Day, Mother's Day, Father's Day and Labor Day ([www.avocado.org](http://www.avocado.org)).

where  $p_{a,s,t}$  is the retail price in cents/unit at retail account  $a$  (e.g., Safeway in Los Angeles) for size  $s$  ( $s = \{\text{large, small}\}$ ) in week  $t$ . The explanatory variables and parameters to be estimated are:

- $\alpha$ : The constant term.
- $p_{a,s,t-1}, \dots, p_{a,s,t-J}$ : Lagged retail prices from week  $t-1$  to week  $t-J$ .
- $w_{m,s,t}, w_{m,s,t-1}, w_{m,s,t-2}$ : The weighted average shipping price for avocados from all origins in cents/unit for size  $s$  avocados shipped to market  $m$  in week  $t$ , and lagged weighted average shipping prices in week  $t-1$  and  $t-2$ .
- $Ad_{m,t}$ : The CAC's advertising expenditure in thousand dollars in market  $m$  in week  $t$ .
- $\alpha_t$ : Time-control variables, which are year-monthly dummies and dummy variables for holidays and events.
- $\alpha_{a,s}$ : Individual effects, i.e., retail account-size individual effects, i.e., size  $s$  avocados sold at retail account  $a$ .
- $\rho_1, \dots, \rho_J$ : Autoregressive coefficients.
- $\theta_0, \theta_1, \theta_2, \varphi$ : Other parameters to be estimated.

The error term,  $\varepsilon_{a,s,t}$ , is specified as  $\varepsilon_{a,s,t} \sim (0, \Omega)$ . The structure of the variance-covariance matrix  $\Omega$  may encompass heteroskedasticity, serial correlation, and correlations between unobserved factors in cross section.

For the long-panel data, a different set of explanatory variables is used, and a linear retail pricing model can be written as follows:

$$\begin{aligned}
p_{a,s,t} = & \alpha + [\rho_1 p_{a,s,t-1} + \dots + \rho_J p_{a,s,t-J}] \\
& + [\tau_0 w_{m,s,t}^{CA} + \tau_1 w_{m,s,t-1}^{CA} + \tau_2 w_{m,s,t-2}^{CA}] \\
& + \gamma^{CH} CH_{m,T} + \gamma^{MEX} MEX_{m,T} \\
& + \phi AD_{m,t} \\
& + \alpha_t + \alpha_{a,s} + \varepsilon_{a,s,t}
\end{aligned} \tag{2}$$

The dependent variable, lagged retail prices, individual effects, and the disturbance term have the same interpretations as those in the model (1) for the short-panel data. The length of the lags of retail price may be different for the long-panel data. The explanatory variables that differ from those in the model for the short-panel data are:

- $w_{m,s,t}^{CA}, w_{m,s,t-1}^{CA}, w_{m,s,t-2}^{CA}$ : The shipping price for size  $s$  Californian avocados shipped from California to destination market  $m$  in week  $t$ , and lagged shipping prices in week  $t-1$  and  $t-2$ .
- $CH_T$ : The import volume of Chilean avocados in one million pounds to the U.S. in month  $T$ . Note that the variable will be canceled and cannot be included if weekly dummies or year-monthly dummies are used, because the import volumes are monthly observations.
- $MEX_{m,T}$ : The import volume of Mexican avocados in one million pounds to the U.S. in month  $T$ . Although the variable has a subscript  $m$ , the import volume of Mexican avocados is not market specific. The subscript  $m$  merely indicates whether Mexican avocado imports were allowed to enter market  $m$  in month  $T$ .
- $AD_{m,t}$ : A dummy variable for the CAC's advertising programs, which equals one if an advertising program is conducted in market  $m$  in week  $t$ , and zero otherwise.

The retail pricing model from equations (1) and (2) is a general presentation. The retail pricing model may have different forms, e.g., the model in first differences, depending on the estimation model that is used.

## 4.2 The shipping price model

A shipping price model is estimated to complement the analysis of retailer pricing behavior for avocados. The stochastic process for shipping price can be modeled as:

$$\begin{aligned}
 w_{m,s,t} = & \alpha^w + [\rho_1^w w_{a,s,t-1} + \dots + \rho_k^w w_{a,s,t-k}] \\
 & + \kappa^w ship_{m,s,t} \\
 & + \zeta^w MEX_{m,T} + \varphi^w Ad_{m,t} \\
 & + \alpha_t^w + \alpha_s^w + \alpha_m^w + \varepsilon_{m,s,t}^w
 \end{aligned} \tag{3}$$

where superscript  $w$  on parameters and the error term denotes that they are in the shipping price model. For the short-panel data,  $w_{m,s,t}$  is the weighted average shipping price for avocados from all origins.  $ship_{m,s,t}$  denotes the total shipment volume of avocados from all origins in million units shipped to market  $m$  in week  $t$ .  $MEX_{m,T}$  denotes the import volume of Mexican avocados in one million pounds to the U.S. in month  $T$ . The variable of Mexican avocado imports has zero values for markets that did not allow Mexican avocado imports.  $Ad_{m,t}$  denotes the CAC's advertising expenditures in thousand dollars in market  $m$  in week  $t$ . Time-control variables are year-monthly dummies and holiday/event dummies.  $\alpha_s^w$  denotes a size dummy variable for small avocados, and  $\alpha_m^w$  denotes market individual effects.

For the long-panel data, the shipping price model is estimated for the shipping price for Californian avocados, and the model has the same form as the model estimated by the short panel data. The only difference is a dummy variable for industry advertising program,  $AD_{m,t}$ , is used. In particular, the advertising variable equals to one if an advertising program is conducted in market  $m$  in week  $t$ , and zero otherwise.

## 4.3 The retail sales model



A retail sales model is estimated to identify seasonal patterns of demand for avocados and the effectiveness of the CAC's advertising programs in terms of promoting demand at the retail level.

The retail sales model is specified in the following form:

$$\begin{aligned}
 q_{a,s,t} = & \alpha^d + [\delta_1 p_{a,s,t} + \dots + \delta_p p_{a,s,t-p}] \\
 & + \tau^d Ad_{m,t} \quad , \quad 4) \\
 & + \alpha_t^d + \alpha_{a,s}^d + \varepsilon_{a,s,t}^d
 \end{aligned}$$

where  $q_{a,s,t}$  is the sales volume in thousand units for size  $s$  avocados at retail account  $a$  in week  $t$ . Retail sales are modeled as a function of contemporaneous and lagged retail prices, advertising expenditure, individual effects, and time-control variables including dummy variables for holidays and events. Superscript  $d$  indicates that parameters and the errors are in the demand model. For the estimation using the short-panel data, the advertising expenditure in dollars spent each week in each promotion market is included as an explanatory variable. For the estimation using the long-panel data, a dummy variable for industry advertising program,  $AD_{m,t}$ , is used. In particular, the advertising variable equals to one if an advertising program is conducted in market  $m$  in week  $t$ , and zero otherwise.

## 5 Hypothesis Tests

Marketing research conducted by the CAC suggests that avocado demand peaks during holidays and national events, such as Super Bowl Sunday, Cinco de Mayo, and Independence Day. As well, avocado demand is expected to be higher during summer months due to a higher incidence of parties, barbeques, etc. we particularly look at holidays and events that are associated with significantly high demand for avocados.

Dummy variables for holidays and events in retail pricing model should primarily capture the effects of holidays and events on retailer pricing behavior, and essentially reflect how retail

margins change during holidays and events when demand for avocados is high. First, avocado production and imports are seasonal, and demand for avocados is expected to be high during some holidays and events. Seasonality in supply and demand for avocados has influence on prices in the upstream market. The effects of demand and supply seasonality on prices in the upstream market can be controlled by shipping prices and/or volumes of imported avocados included in the retail pricing model. Second, we do not expect that other marginal retailing costs change significantly during holidays and events. Other marginal retailing costs are usually pooled among thousands of products that retailers carry. Even if these marginal costs change during some holidays and events, they are likely to change when the aggregate retail demand is high (e.g., retail demand is high during Christmas and New Year's Day season), but are unlikely to change when the idiosyncratic demand for avocados is high (e.g., demand for avocados is high in the week of Super Bowl Sunday). Therefore, the effects of holidays and events on retail prices should effectively reflect their influence on retail margins.

After controlling for the effects of holidays and events on shipping prices, demand shocks during holidays and events are expected to have no significant effects on retail prices and margins under perfect competition. If retail prices and margins increase when seasonal demand for avocados is high, it conforms with the prediction of a standard model on oligopoly power.<sup>4</sup> That is, retailers set retail prices above the perfect competitive level during demand peaks and sales volume is reduced relative to what would be sold under the perfectly competitive pricing. This behavior is detrimental to producers' welfare.

---

<sup>4</sup> Retailers face perfectly elastic demand under perfect competition. We expect that demand shocks only have effects on prices at the aggregate level, i.e., shipping prices, under perfect competition. After controlling the effect of demand shocks on shipping prices, holidays and events should not have positive significant effects on retail prices. Moreover, the retail margin is constructed as the difference between retail price and shipping price. By subtracting shipping prices from retail prices, it subtracts the increase in retail prices due to increase in shipping prices during peak demand season. Hence, holidays and events should not have positive significant effect on the retail margin under perfect competition.

On the other hand, empirical studies such as Chevalier, Kashyap, and Rossi (2003) and Hosken and Reiffen (2004), have found retail prices are significantly lower during seasonal demand peaks for grocery retail products. Chevalier, Kashyap, and Rossi (2003) examine three classes of theories that offer different explanations for countercyclical price movement. See Chevalier, Kashyap, and Rossi (2003) and section 2 for a literature review. According to a model of economies of scale in search by Warner and Barsky (1995) and a tacit collusion model by Bernheim and Whinston (1990), retail prices and margins are lower when the aggregate demand is higher, such as during Thanksgiving and Christmas/New Year holidays; but retail prices and margins do not decrease when the idiosyncratic demand for avocados is higher, such as during Super Bowl Sunday and Cinco de Mayo. However, according to a loss-leader model by Lal and Matutes (1994), retailers could use avocados as a sales item to attract consumers into the store when avocados are popular in some season. Therefore retail prices and markups for avocados could be lower during idiosyncratic demand peaks for avocados.

Nevo and Hatzitaskos (2006) point out that retail prices for a generally defined product category could be lower during seasonal demand peaks, because consumers shift their demand from quality and high priced products to cheaper products when demand for a generally-defined product category is high. Therefore, the countercyclical price movement over seasonal demand cycles is explained by consumers' behavior instead of retailers' tactic pricing behavior.

To test whether Nevo and Hatzitaskos' explanation is relevant for retail prices for avocados, we examine how retail prices for small and large avocados change during seasonal demand peaks. Small and large avocados are regarded as nearly homogenous products. However, large avocados are more expensive than small avocados according to shipping price in \$/pound. For example, shipping price for large avocados was 14 cents per pound higher than small

avocados for avocados from all origins, and shipping price for large avocados was 22 cents per pound higher than small avocados for Californian avocados. In the retail sales model, we will also test whether demands for large and small avocados are significantly different.

This may occur because small avocados require more preparation and have less uniform texture compared with large avocados, and therefore may be considered having lower quality relative to large avocados. Following Nevo and Hatzitaskos' argument, the difference in retail prices due to difference in quality may amplify when demand is high, and consumers substitute away from high-priced items with cheaper ones. If Nevo and Hatzitaskos' explanation is relevant, we should observe the weighted average retail prices for an aggregate size avocados decrease, but retail prices for large and small avocados should not decrease during seasonal demand peaks. Otherwise, it suggests the countercyclical price movements over seasonal demand peaks are mainly explained by retailers' strategic pricing behavior. Nevo and Hatzitaskos find that from almost all the products they study, decreases in retail prices for a product category are largely explained by increases in the shares of cheaper products.

Consider now the expected effects of the CAC's promotions on 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 implies that retail prices and markups should fall during the CAC's promotion periods, given that the promotions are successful in increasing demand. In contrast, Warner and Barsky, and Bernheim and Whinston do 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, will lower retail prices and 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 about the effectiveness of the advertising programs.

## **6 The Econometric Model and Model Selection**

### ***6.1 The Dynamic Panel Model, GMM, and Instrumental Variables***

The microeconomic panel dataset available for this study enables scrutiny of retailer pricing behavior at the micro level and application of advanced panel models. This section discusses econometric methods and tests that are employed to estimate the empirical models in this study. Although the main purpose is to obtain the estimates of the seasonal dummies, sound empirical and econometrics models are performed.

A major complication of the estimation is the possibility of inconsistent parameter estimation caused by endogenous variables. IVs are a standard way to deal with endogenous

variables. Panel data usually provide a surfeit of IVs relative to cross-sectional data, because regressors in other time periods may be valid instruments for endogenous variables in the current period.

Dynamics are introduced in all three empirical models. For example, Dynamics in the retail pricing model to capture lagged response in retail price to changes in explanatory variables and to measure state dependence in retail price on its past values. We test the existence of the dynamics and the length of the lags in the presence of dynamics. Exogeneity assumptions conditional on individual effects are based on the correlation between regressors and the individual time-varying error term, and permit the correlation between regressors and unobserved individual effects. The correlation between an explanatory variable and individual effects gives rise to endogeneity and inconsistent estimation. This is a prominent issue in estimating dynamic panel models, because lagged dependent variables are inevitably correlated individual effects. A natural way to deal with the endogeneity due to the correlation between regressors and individual effects is to expunge individual effects. Therefore, fixed effects models, i.e., the within model and the first-differences model, are employed to purge unobserved individual effects.

Mean differencing gives rise to bias because it utilizes past values of a variable. However, this bias diminishes as the time period for the panel data increases. This is convincing as the data utilized in this study have long panels. The within model does not require instruments for the transformed lagged dependent variables and other predetermined variables, given the bias is insignificant. This leads to efficiency gain. The FD model has been a canonical choice and performs well in estimating dynamic panel models. Arellano and Bond (1991) demonstrate that estimation of the FD model by the GMM exhibits the least bias and variance in estimating

parameters of interest compared with the OLS and within estimations based upon Monte Carlo simulations

Panel data permit regressors in other periods to be potentially valid instruments for endogenous regressors in the current period. This leads to an abundance of IVs, and hence an excess of moment conditions for estimation relative to the number of coefficients to be estimated. Further, the disturbance term in panel models is usually not i.i.d. These circumstances introduce the possibility of more efficient estimation by the Generalized Method of Moments (GMM). The GMM was introduced by Hansen (1982), and since then the GMM has become increasingly popular and particularly attractive in estimating panel models.

This study applies a hybrid estimator that combines the Anderson-Hsiao estimator and the Arellano-Bond estimator. First, the Anderson-Hsiao level or difference estimator uses one lagged variable as an instrument, i.e., uses  $y_{a,t-2}$  or  $\Delta y_{a,t-2}$  to instrument  $\Delta y_{a,t-1}$ , and the model is estimated by the base-case GMM (Anderson and Hsiao, 1982). Second, the Arellano-Bond estimator uses more than one lag of a variable as instruments, and the model is estimated by the stacked GMM (Arellano and Bond, 1991). The Arellano-Bond estimator uses lagged variables in levels as excluded instruments in the original presentation. Third, this study applies an estimator that uses more than one lag of a variable or multiple variables as excluded IVs, and estimates the model using a base-case GMM. The estimations will use lagged variables in levels as well as in FD as excluded IVs to compare which one performs better. The estimations will use lagged variables of the endogenous variable, and use lagged variables of the endogenous variable and other exogenous variables as excluded IV, respectively. Because both the short-panel and the long-panel data have relatively large number of time periods, the number of lags for excluded IVs will be tested. Nonetheless, We will also test whether the stacked GMM performs well for

estimation by the short-panel data, but will restrict the number of variable in the stacked form in the IV matrix to one. The one-step stacked GMM is preferred to the two-step stacked GMM.

In sum, econometric methods that will be employed to estimate empirical models include (i) the within estimation, (ii) the base-case one-step GMM estimation with robust standard errors for the FD model, (iii) the base-case two-step GMM with the Windmeijer corrected standard errors for the FD model (Windmeijer, 2005), and (iv) the one-step stacked GMM for estimation by the short-panel data. Standard errors and the estimated weighing matrix used in the second-step of the two-step GMM are robust to heteroskedasticity and arbitrary patterns of autocorrelation within individuals.

## **6.2 Model Specification Tests**

Model specification tests that are performed are pertinent to choosing between the OLS, the one-step GMM, and the two-step GMM estimators. The IV estimation can be applied to obtain consistent estimation, if some explanatory variable is endogenous. The endogeneity due to the correlation between regressors and the individual-specific transitory error term,  $\varepsilon_{a,t}$ , is the subject matter, whereas the endogeneity due to the correlation between regressors and unobserved individual effects can be dealt with by fixed-effects models.

If all regressors are exogenous, but some variables are treated endogenous and excluded from the IV set, the IV estimator is inevitably inefficient compared to the OLS estimator. The loss of efficiency can be substantial, especially when the instruments are weak (Cameron and Trivedi, 2005, p. 275; Baum, Schaffer, and Stillman, 2003). However, even if all regressors are exogenous, the two-step GMM still has the attraction of being more efficient than OLS if  $\varepsilon_{a,t}$  is not i.i.d., and is at least as efficient as the OLS if  $\varepsilon_{a,t}$  is i.i.d. (Cameron and Trivedi, 2005, p. 747, p. 753). If the error term is not i.i.d., the two-step GMM is more efficient than OLS because an



optimal GMM can be applied to an overidentified model, which includes all regressors and values of regressors in other periods as additional instruments. The first-step estimation (inefficient but consistent) used to generate the residuals is an OLS rather than an IV estimation. The efficiency gain is analogous to that for cross-section data with heteroskedasticity (Cameron and Trivedi, 2005, p. 753). If all regressors are orthogonal to the errors, and the errors are i.i.d., the two-step GMM equals the one-step GMM, is the efficient GMM, and is equivalent to OLS. In this case, additional IVs, which are correctly excluded from the model by nature, do not need to be included in the IV set.

Therefore, not only testing for endogeneity is important in determining between the OLS and the GMM that is used to implement the IV estimation, but also is testing for heteroskedasticity. Given some regressor is endogenous, and if the errors are heteroskedastic, the two-step GMM is more efficient than the one-step GMM; and if errors are homoskedastic, the two-step GMM is no worse asymptotically than the one-step GMM estimator.

Taken altogether, the existence of endogenous regressors ensures the choice of the IV by the one-step or two-step GMM is preferred to OLS. If the errors are heteroskedastic, the two-step GMM is more efficient than OLS in the presence of endogeneity, or the one-step GMM in the absence of endogeneity; if the errors are homoskedastic, the two-step GMM is no worse than OLS or the one-step GMM asymptotically. However, the efficiency gain of the two-step GMM comes with the cost of finite sample bias. If errors are heteroskedastic, the one-step GMM or OLS are less efficient, but still are consistent. For this reason, even if errors are heteroskedastic, the one-step GMM or the OLS estimation should be obtained as a robustness check. In this case, robust standard errors need to be applied to the one-step GMM or the OLS to ensure correct inference.

IVs can be applied to attain consistent estimation if some regressor is endogenous. An IV is valid if it is orthogonal to the contemporaneous error term. An IV is irrelevant if it is uncorrelated with the endogenous variable. If there are too few relevant instruments with respect to the number of parameters to be estimated, the model is underidentified. Therefore, both the validity and relevance of an IV are necessary for consistency (Cameron and Trivedi, 2005, p. 100). A “good” instrument is exogenous to the error term and highly correlated with the endogenous variable. It is practically difficult to obtain an instrument that is highly correlated with the endogenous variable, but is also a correctly excluded variable in the model. This gives rise to weak instruments. If an IV is weakly correlated with the endogenous variable, it could lead to low precision, finite-sample bias and even challenge asymptotic property of the IV estimation (Cameron and Trivedi, 2005, p. 107–108). Diagnostic tests are performed to test validity of IVs as well as to detect weak instruments.<sup>5</sup> Further, panel data allow variables in other periods to serve as instruments. The presence of serial correlation in the error term can render some lags of the variable to be invalid instruments. Arellano and Bond (1991) develop a *Z* test for autocorrelation in errors, in particular pertinent to the FD models.

The overidentifying restriction tests are applied to assess whether IVs are exogenous. In particular, if errors are heteroskedastic or clustered, the Hansen *J* test statistic are applied to test the joint validity of the whole IV set and the *C* test (or difference-in-Hansen test) to test validity of a subset of IVs or endogeneity of a set of explanatory variables. If errors are homoskedastic, the Sargan test that is a special case of the Hansen *J* test is for testing validity of IVs, and Durbin-Wu-Hausman tests are for testing endogeneity of explanatory variables. Nevertheless,

---

<sup>5</sup> Baum, Schaffer, and Stillman (2003, 2007) and Roodman (2006) provide excellent summary for the tests for the relevance of IVs and weak IVs, and discussions of practical issues regarding weak IVs. The tests for the relevance of IVs and weak IVs applied in this study are based on those summarized in Schaffer, and Stillman (2003, 2007). Cameron and Trivedi (2005, p. 103–112, p. 177, p. 751) also provides a thorough survey on diagnostic tests for relevance of IVs and estimation issues regarding weak IVs.

tests for orthogonality conditions and tests for endogeneity are closely related. Because heteroskedastic errors exist in empirical models in this study.

### **6.3 A Summary on Model Selection**

This section discusses the selection of estimation models, and briefly summarizes the estimation results for each empirical model. The estimation results for alternative models and model specification tests are not presented in this paper, but are available upon request. First, the results suggest that the base-case GMM is preferred to the stacked GMM. The stacked GMM estimation performed poorly due to the proliferation of moment conditions when the number of time periods is large. Second, the test results suggest that heteroskedasticity is present in all empirical models. Therefore, robust standard errors are applied for the one-step GMM, and the two-step GMM may be more efficient than the one-step GMM in finite sample. The standard errors from the one-step GMM estimation are cluster-robust, i.e., standard errors are robust to heteroskedasticity and arbitrary patterns of autocorrelation within in each individual (each cross-sectional unit) by clustering at the individual level. The estimated weighting matrix in the second step of the two-step GMM estimation is also cluster-robust. The standard errors are the Windmeijer corrected standard errors.

The Hansen  $J$  tests and the  $C$  tests are the relevant tests for the validity of IVs when the errors are heteroskedastic and clustered. Various weak identification tests that are distributed as  $F$  or  $\chi^2$  are cluster-robust as well. Extra lags of one or more variables are introduced as the excluded instruments for the two-step GMM in the absence of the endogenous regressor(s), or for the IV estimation by either the one-step or two-step GMM in the presence of the endogenous regressor(s). The starting lag length of the excluded IVs is twelve. The preferred lag length of the excluded instruments is chosen based on the following criteria: (i) the robustness of the estimated

coefficients and the size of the standard errors, (ii) the Hansen  $J$  tests and the Arellano-Bond autocorrelation tests for the correct model specification and/or exogeneity of the IVs, and (iii) the tests for the redundancy of extra instruments.

The estimation results for the retail pricing model are consistent from the estimations by the short-panel and long-panel data. The FD model is preferred to the within model to examine the dynamics of retail price and the effects of shipping price. The estimates of strictly exogenous variables, e.g., holiday dummies, avocados imports, and promotions, remain consistent in the within model, and are examined by the within model. The estimation results from the preferred models for the retail pricing model are reported in table 1. The preferred models are: a within model with an AR(6) and one lag of shipping price estimated by the one-step GMM for both the estimations by the short-panel and long-panel data; and a FD model that is an IV estimation by the two-step GMM in which the lag one retail price is instrumented by lag 4-7 of retail price as excluded IVs for both estimations by the short-panel and long-panel data.

The estimation results for the retail sales model suggest that there is no consumption habit for avocados on weekly basis, and retail price and its lags are orthogonal to the error term. Holiday effects and promotion effects are mainly examined by the within model. The within models yield consistent estimates for these variables, as well as for the retail price and its lags. The within and FD models performed equally well in estimating the price coefficients by the long-panel data. However, the FD model performed better than the within model in estimating price coefficients, since the IV estimation of the within model is relatively weak compared with the IV estimation of the FD model. Table 2 presents the estimation results of the preferred models, which are: (i) a within model for the long-panel data by the two-step GMM, in which lags 3-12 of retail price are introduced as the excluded IVs to obtain Hansen  $J$  test, and to see

whether the two-step GMM improves efficiency in the presence of heteroskedasticity; (ii) a FD model for the long-panel data estimated by the two-step GMM, in which lags 3-11 of retail price in FD are introduced as excluded IVs to improve estimation efficiency and to obtain the Hansen J test; (iii) a within model for the short-panel data estimated by the IV estimation and the one-step GMM, in which the contemporaneous retail price is instrumented by lags 3-9 of retail price as excluded IVs; and (iv) a FD model for the short-panel data estimated by the two-step GMM, in which lags 3-8 of retail price are introduced to improve estimation efficiency. The estimated price elasticity of demand at means is also reported for each preferred model. The price elasticity ranges from -1.36 to -1.83, indicating that avocado demand at the level of the grocery chain is price elastic.

Table 3 presents the estimation results for the preferred within and FD models for the shipping price model. The results of the overidentification test suggest that the set of explanatory variables are orthogonal to the error term and the estimates are consistent.

## **7 The Effects of Holidays/Events on Retail Sales, Retail Price, and Shipping Price**

A variable may have different interpretations in the FD model and in the within model. For variables that are monthly or change little over weeks, e.g., monthly import volumes and promotion expenditures, they are dealt with differently in the FD model and in the within model. For dummy variables, e.g., holiday dummies, they are not transformed in either the FD or the within model, and their effects have different interpretations in the FD and the within models. This is generally applied to all empirical models, and is mainly discussed in the case of the retail pricing model as follows. First, holiday dummy variables are not transformed in the FD model or the within model, but have different meaning in these two models. Holiday effects on retail price

in mean differences are similar to holiday effects on retail price in levels. However, holiday dummies in the FD model measures the holiday effects on the change in retail price between two weeks. Holiday effects estimated from the FD model may not provide accurate evidence on whether retailers changed retail prices during holiday seasons for holidays that are close to each other (e.g., Christmas and New Year's Day), or holidays that span two weeks of shopping time (e.g., for a holiday on Tuesday, both the weeks before and during the holiday are relevant). For example, if retailers reduced retail prices in both the week prior to and the week during a holiday, the change in retail price between these two weeks may not be significant, although the deviation of retail price from its average may be significant. On the other hand, for example, if retailers reduced retail prices for a holiday in a season associated with higher prices, e.g., Valentine's Day and President's Day, retail prices may not be significantly lower than its average, but retail prices may be significantly lower during the holiday week than in the previous week, or retail prices may be significant lower than the average prices in that season. For holidays that have one shopping week, e.g., Super Bowl Sunday, the estimates from the within and the FD model could yield consistent conclusion, although may not be the same. In sum, estimated holiday effects in the within and the FD models provide different information on how retail prices change during holidays associated with high avocado demand.

Second, dummy variables and variables that do not change over weeks, e.g., yearly and monthly dummies, promotion variables, and variables of monthly avocado import volumes, are mainly examined by the within model. These variables are not transformed and mainly serve as control variables in the FD model. If monthly import volumes, for example, were transformed by first differencing, they would be only relevant to retail price in the first and last weeks in a month. Furthermore, the promotion variable in the within model is measured by promotion expenditure

and is a continuous treatment variable in models estimated by the short-panel data, and is an indicator variable and a binary treatment variable in models estimated by the long-panel data. An advertising campaign lasted three weeks for the radio advertising and four weeks for the outdoor promotions, and the promotion expenditure did not change between weeks during an advertising campaign. A promotion variable in FD only measures changes in promotion expenditure the first and last weeks of an advertising campaign and changes in expenditure between consecutive campaigns. Instead, import volumes and promotion expenditure in levels are included in the FD model to control different shocks to changes in retail prices in different markets. The estimated coefficients of these variables in the FD model can provide meaningful information, although cautions should be taken when interpreting their effects. For example, suppose the increase in monthly avocado imports is associated with significant decrease in retail prices in mean differences, and hence in levels. However, the increase in monthly avocado imports may not have significantly negative effects on changes in retail prices between weeks within a month.

### ***7.1 Demand for Avocados during Holidays/Events***

The retail sales model includes twelve holiday dummies indicating fourteen holidays and events that are expected to have higher demand for avocados according to the CAC. Table 4 reports the estimated holiday effects on retail sales for avocados. A holiday dummy variable may represent more than one holiday/event, e.g., Christmas/New Year, and may indicate more than one shopping week for a holiday/event depending on which day of the week the holiday/event falls in.<sup>6</sup>

Super Bowl Sunday, Christmas/New Year, Cinco de Mayo, Labor Day, and

---

<sup>6</sup> 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. See section 6.1.2 for further discussion on modeling holiday effects.

Independence Day are the top five holidays/events associated with significantly higher demand for avocados, as suggested by the estimates from the within models. These holidays/events, except Cinco de Mayo, had larger effects on avocado demand estimated by the short-panel data than their effects estimated by the long-panel data. This implies that these holidays/events might have stronger effects on avocado demand in recent years, although it has been “conventional” to consume avocados in these holidays/events. These five holidays/events are also identified as the holidays/events with peak demand for avocados by the estimates from the FD model. The FD model estimates the change in retail sales between two weeks, and is likely to underestimate the effect of Christmas/New Year that covers two to three shopping weeks.<sup>7</sup> There were on average 17,590 (8,180) units more avocados for each size sold at a retail account in the week of Super Bowl Sunday; and there were on average 13,420 (12,330) units more avocados for each size sold at a retail account in the week of Super Bowl Sunday than in the previous week, estimated by the short-panel (long-panel) data.

Easter and Memorial Day had significantly higher demand according to the estimates by the long-panel data, although the magnitude of the effects was small compared with the effects of the top five holidays/events. Easter and Memorial Day had a positive but not statistically significant effect on retail sales at the 5% statistical significance level, according to the estimates by the short-panel data. Valentine/President’s Day are identified as holidays/events with significantly higher demand by the FD model, but not by the within model. This implies that demand for avocados during Valentine/President’s Day might be significantly high in a season with low demand for avocados (e.g., from January to April), but was not significantly higher

---

<sup>7</sup> Holiday variables are dummy variables and are not differenced in either the within model or the FD model. A holiday dummy in the within model represents the deviation of retail sales from its individual means due to the holiday, whereas a holiday dummy in the FD model represents the change in retail sales between the current week and the previous week. See section 9.1 for a discussion on dummy variables including time-control variables, holiday dummies, and promotion variables in the within and the FD models.



compared with the year-around average demand for avocados.

Academy Awards, Mothers' Day, Fathers' Day, and Thanksgiving did not have significantly higher demand for avocados. These holidays/events except Thanksgiving are dropped in the retail pricing and shipping pricing models. Thanksgiving is regarded as a holiday for shopping, and hence is expected to be associated with a higher aggregate retail demand. Thanksgiving is retained in the retail pricing and shipping pricing models to examine price movement when the aggregate retail demand is high.

Table 4 also reports the estimated seasonality of retail sales for avocados from month to month.<sup>8</sup> October is the base-line month. The CAC suggests that demand for avocados is correlated with warm weather. As expected, demand for avocados was high in the summer months May through September, with May and June having the highest demand, based on the estimates by the short-panel and the long-panel data.

## ***7.2 The Effects of Holidays/Events on Retail Price***

The effects of holidays/events on retail prices for avocados are expected to reflect the effects of holidays/events on retail margin, after controlling variation in shipping price during holidays/events, and assuming variation in unobserved cost factors has been controlled by year-monthly dummies and individual effects, or has no significant change during holidays/events. If demand shocks during some holidays/events have effects on price for avocados, they are expected to have effects on shipping price which has been controlled in the retail pricing model. Under perfect competition, positive demand shocks are expected to have no significant effects on the retail margin. The movement of shipping price during holidays/events is examined in the next section to see whether retail price and shipping price move in the same direction during

---

<sup>8</sup> The model is estimated by the year-monthly dummies. The year-monthly dummies are generated by the yearly dummies, monthly dummies, and their interacted terms. The estimates for the monthly dummies are reported.

holidays/events.

Holidays/events that have sizable and statistically significant effects are the focus of the analysis. Year-monthly dummies cannot control shocks of unobserved cost factors during holidays/events, although their effects are expected to be small. A small and/or insignificant effect of a holiday/event on retail price may be due to the effect of unobserved cost factors during the holiday/event. See section 6.1.3 for a discussion of modeling cost factors in the retail pricing model and section 6.1.4 for a discussion of time-control variables in the retail pricing model.

The retail pricing model estimated by the short-panel data uses the weighted average shipping price for Californian and imported avocados, and the retail pricing model estimated by the long-panel data uses the shipping price for Californian avocados. Therefore, the retail pricing model by the short-panel data controls variations in procurement costs better than the retail pricing model estimated by the long-panel data. Therefore, we, in particular, examine the effects of all included holidays/events estimated by the short-panel data, and the effects of holidays/events during the peak season for Californian avocados (e.g., May, June, and July) estimated by the long-panel data.

Table 5 presents the estimated effects of holidays/events on retail price. Some holidays/events evidently had significant effects on retail price for avocados. Among the top five holidays/events associated with significant higher demand for avocados, Christmas/New Year, Super Bowl Sunday, Cinco de Mayo, and Labor Day were associated with significant lower retail prices relative to the average price, and significant price reductions in the shopping week(s) during the holiday/event relative to the week prior to the shopping weeks of the holiday/event. Super Bowl Sunday and Cinco de Mayo had the strongest effect on retail price among all holidays/events. During Super Bowl Sunday, retail price was 18.83 cents/unit lower than its

average level, and 25.86 cents/unit lower than the price in the previous week; during Cinco de Mayo, retail price was 15.52 cents/unit lower than its average level, and 14.10 cents/unit lower than the price in the previous week.

Thanksgiving and Christmas/New Year are considered national holidays when people go out for shopping. Therefore, the aggregate demand is expected to be high during these holidays, as suggested by Warner and Barsky (1995) and Chevalier, Kashyap, and Rossi (2003). Retail sales for avocados were significantly higher, and retail price for avocados was significantly lower during Christmas/New Year. The effects of Thanksgiving on retail sales and retail price are insignificant in magnitude and/or by statistical significance.

Independence Day was also associated with higher demand for avocados. The estimates, except the estimate from the within model by the short-panel data, suggest that Independence Day had no significant effect on retail price. Memorial Day and Valentine/President's Day had no sizeable and/or statistically significant decrease in retail price relative to the average level. However, both Memorial Day and Valentine/President's Day had significantly lower retail price compared with the price in the week prior to the holidays/events. Retail sales were slightly higher, and retail price was significantly higher during Easter.

The results suggest that retail price and retail margin were significantly lower during holidays/events associated with high idiosyncratic demand for avocados, such as Super Bowl Sunday and Cinco de Mayo; retail price and retail margin were not significantly lower during holidays associated with high aggregate consumer demand, such as Thanksgiving; and retail price and retail margin were significantly lower during Christmas/New Year that is associated with higher aggregate demand and higher demand for avocados. First, the results are not consistent with the predications by Warner and Barsky (1995) or Bernheim and Whinston (1990)

that retail prices or retail markups fall during the periods with high aggregate consumer demand, but not during the periods with high idiosyncratic demand. Second, the estimation results present evidence in support of the hypothesis by Lal and Matutes (1994) that retail prices or retail markups are lower, *ceteris paribus*, during high-demand periods for avocados, when the aggregated consumer demand is not necessarily higher.

Nevo and Hatzitaskos (2006) propose an alternative explanation for the countercyclical price movement of differentiated products over demand peaks. In particular, the increase in demand for a product category during some holidays/events is driven by the increase in demand for the cheaper product(s) within the product category. As a consequence the average price for the product category is lower during the holiday/event. Small and large avocados are regarded as nearly homogenous products. Nonetheless, retail demand for small avocados was lower than retail demand for large avocados (see section 10.1). Shipping price in \$/pound is higher for large avocados than for small avocados (see section 9.1). This may suggest that small avocados may have lower quality than large avocados, since small avocados may require more preparation and have less uniform texture than large avocados. According to Nevo and Hatzitaskos' theory, retail demand for small avocados is expected to be relatively higher than demand for large avocados during holidays/events associated with high demand for avocados, and retail price or retail margin is not expected to be lower for either size of avocados.

The retail sales and retail prices in this study are for large and small avocados at the individual PLU code level. We examine whether the change in demand for small avocados is greater than the change in demand for large avocados during Christmas/New Year, Super Bowl Sunday, and Cinco de Mayo, and whether the change in the retail price for small avocados is smaller than the change in the retail price for large avocados during these three holidays/events.

This is done by introducing dummy variables indicating large and small sizes to holiday dummy variables for these three holidays/events. Then We test whether the effects of these holidays/events on retail sales and retail prices are equal for large and small avocados.

The evidence does not support the prediction by Nevo and Hatzitaskos. The results for retail sales and retail price for avocados are presented in table 4 and table 5, respectively. During Christmas/New Year, retail sales for small avocados were significantly higher than retail sales for large avocados at the 90% significance level by the short-panel data, but were not significantly different from retail sales for large avocados by the long-panel data. Nevertheless, retailers discounted both large and small avocados equally. During Super Bowl Sunday and Cinco de Mayo, retail sales and retail price for avocados were not significantly different between large and small avocados.

### ***7.3 The Effects of Holidays/Events on Shipping Price***

The estimated effects of holidays/events on shipping price provide evidence on how shipping price changed, and whether the shipping price and the retail price moved in the same direction during holidays/events with high demand for avocados. Holiday dummies in the shipping price model capture both demand and supply shocks associated with those holidays/events. In contrast, holiday dummies in the retail pricing model measure the effects of holidays/events on retail price and retail margin in addition to the effects of the demand and supply shocks during these holidays/events in the upstream market that have been controlled by shipping price. Therefore, a negative effect of a holiday/event associated with a high demand for avocados on the shipping price may indicate that the shipping price decreases, because supply adjustment dominates the demand shock during a holiday/event due to, for example, changes in supplies of Californian and/or imported avocados.

A holiday/event is likely to have its effect, if any, on shipping price one or more weeks before the holiday/event takes place. Retailers make their procurement decision weeks before a holiday/event based on their expectations of the demand shock associated with the holiday/event. A holiday dummy in the shipping price model corresponds to a single week which the holiday/event is in. A lead variable is introduced for each holiday/event to indicate the week prior to the week which the holiday/event is in. One lead is preferred to more leads, since holiday dummies and their leads would overlap with each other if holidays/events are close to each other. Further, as suggested by the estimates from the retail pricing model, retail price is most likely to be influenced by the shipping price in the previous week. The dummy for Valentine/President's Day and its lead follow closely with the dummy for Super Bowl Sunday and its lead, and therefore Valentine/President's Day is dropped from the shipping price model.

The effects of holidays/events are the effects on the weighted average shipping price for Californian and imports avocados estimated by the short-panel data, whereas they are the effects on the shipping price for Californian avocados estimated by the long-panel data. If the demand shock during a holiday/event is anticipated and its magnitude correctly forecast, and if grower-shippers are able to arbitrage efficiently, then the shipping price before the holiday/event should not be significantly different from the shipping price in other periods.

The results are presented in table 6. The effects of Super Bowl Sunday, Cinco de Mayo, and Christmas/New Year on shipping price are of particular interest. The results suggest that retail price moved in an opposite direction from shipping price during Christmas/New Year, Super Bowl Sunday, and Cinco de Mayo, and therefore retail margins were significantly lower during these holidays/events. Super Bowl Sunday had no significant effect on the weighted average shipping price or the shipping price for Californian avocados prior to the event, implying

that grower-shippers were successful in intertemporal arbitrage, i.e., using supply response to “spread” the impact of the demand across multiple weeks.

The shipping price in the week of Super Bowl Sunday decreased significantly from the shipping price in the previous week. This may be because retailers procured avocados prior to the event, and the demand for avocados at the shipping level plummeted in the week of the event. The weighted average shipping price was significantly higher before Christmas/New Year and Cinco de Mayo. The shipping price for Californian avocados was significantly higher in the week before Cinco de Mayo.

The effects of some holidays/events on shipping price are statistically significant, but the size of holiday effects are small compared with the size of holiday effects on retail price. As mentioned, year-monthly dummies and holiday dummies in the shipping price model are employed to capture unobserved cost as well as demand shocks. Therefore, the estimated effects of holidays/events on weekly shipping price may represent the effects of unobserved cost and/or demand shocks.

A significant effect of a holiday/event on shipping price may suggest failure of efficient intertemporal arbitrage. Inefficient arbitrage may occur, because the magnitude of the shock was not anticipated, or the magnitude of competitors’ supply response was not correctly anticipated. This may be true particularly during seasons when multiple countries are producing—Chile, Mexico, the U.S. (California). In addition, there are impediments to arbitrage even if grower-shippers correctly anticipate the shock and its magnitude. Those impediments may depend upon facets of growing, harvesting, and storing avocados. See sections 9.5 and 9.6 for discussions of arbitrage efficiency at the shipping level in the contexts of the effects of shipment volume, the CAC’s promotion programs, and Mexican avocado imports on shipping price for avocados.

#### ***7.4 The Effects of the CAC's Promotion Programs on Retail Sales, Retail Price, and Shipping Price***

Consumer advertising programs, such as media advertisements, have been widely utilized to increase demand for a product. If the promotions are successful, retail sales should rise. The findings on retail sales for avocados suggest that the CAC's promotion programs had positive effects on retail sales for avocados. The promotion effects on retail sales estimated by the long-panel data are statistically significant and higher than the promotion effects estimated by the short panel data, which are positive but not statistically significant. See section 10.4 for a discussion of the results on the effects of the CAC's promotion programs on retail sales for avocados.

In addition, if arbitrage at the shipping level was efficient between promotion and non-promotion markets, and between promotion and non-promotion weeks or periods, the CAC's promotion programs are expected to have no significant effects on shipping prices at the destination market level. The farm price is expected to rise given the CAC's promotion programs were successful in increasing demand for avocados. The results on shipping price for avocados indicate that both spatial and intertemporal arbitrage was efficient in response to shocks generated by the CAC's promotion programs. See section 9.6 for discussions of the effects of the CAC's promotion programs on shipping price for avocados and the implications for arbitrage efficiency.

A priori expectations for the impact of promotions on retail price are less clear. 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 the CAC's 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 the effectiveness of the CAC's promotion programs.

If retailers did not retain the benefits of increase in demand for avocados due to the CAC's promotion program, we expect that the benefit of the promotions passes on to the farm level, and as a result, farm price increases. Since arbitrage at the shipping level was efficient in response to demand shocks generated by the CAC's promotions, the effect of demand expansion should transmit fully back to the farm level. If retailers reduced retail prices for avocados in response to the CAC's promotion programs, the effects of the CAC' promotions would be augmented by additional increase in quantity demanded for avocados due to retailers' price response.

Table 7 presents the estimated effects of the CAC's promotion programs on retail sales, retail price, and shipping price for avocados. The estimates of the promotion effects are obtained from the retail sales model, the retail pricing model, and the shipping price model, which all use weekly dummy variables as time-control variables. Therefore, the estimated promotion effects on retail sales are slightly different from those presented in section 10.4 from the retail sales model that uses yearly and monthly dummy variables.<sup>9</sup> However, the conclusions remain the same. The main purpose of using the weekly dummy variables is to analyze promotion effects on retail price, retail sales, and shipping price for avocados that are estimated from the models that apply the same time controls. Applying weekly dummy variables, although it offers better

---

<sup>9</sup> The estimated promotion effect is 0.030, not statistically significant, from the within model by the short-panel data; the estimated promotion effect is 3.346, significant at the 1% statistical significance level, from the within model by the long-panel data. The results can be found in table 10.5.

control over unobserved shocks, did not result in significant changes in estimates or different conclusions.

The CAC's promotion programs were associated with higher, but not statistically significant, retail sales estimated by the short-panel data, and with significantly higher retail sales estimated by the long-panel data. The separate estimates for radio and outdoor promotions from the short-panel data indicate that radio advertising was more effective than outdoor promotions in terms of generating retail sales per advertising dollar. The effect of outdoor promotions varied widely relative to radio advertising, since the standard error of the estimate of outdoor promotions is more than twice as large as those of the estimates of overall promotions and radio advertising. Nevertheless, estimates from the short-panel data show that neither promotion program had a significant effect on retail sales.

Next, the effects of the CAC's promotions are calculated by the estimated promotional effects in unit/dollar by the short-panel data and the actual promotion expenditure in 2003 and 2004. The promotional effects are calculated for each radio campaign during 2003 and 2004 by the estimated effect of radio advertising (0.033), and the annual average promotion effects are calculated for radio and outdoor promotions, and the overall promotion program in 2003 and 2004 by the estimated effect of overall promotions (0.030). The effects of outdoor promotions are not calculated from the estimated coefficient of outdoor promotions, which is negative and statistically insignificant, and has considerably large standard error.

Overall, there were 566 units and 621 units more avocados of each size sold at a retail account in a promotion market during a promotional week in 2003 and 2004, respectively. As the average weekly promotion expenditure on radio advertising was larger than the expenditure on outdoor promotions, the effect of radio advertising was 1.73 times as large as the effect of

outdoor promotions, given the estimated promotion effect per advertising dollar is the same for both radio and outdoor promotions. During a radio campaign, there were 612 units and 683 units more avocados of each size sold at a retail account in a promotion market during a promotion week in 2003 and 2004, respectively.

The estimates from the long-panel data show that there were 3,438 units more avocados of each size sold at a retail account in a promotion market during a promotion week. The effect of radio advertising was twice as large as the effect of outdoor promotions. In particular, there were 3,920 units and 1,903 units more avocados of each size sold at a retail account in a promotion market during a week of radio advertising and outdoor promotion, respectively. The estimated promotion effects by the long-panel data are considerably larger than those by the short-panel data.

The CAC's promotion programs had positive, but not statistically significant effect on shipping prices. Shipping prices during promotion periods were 0.116 (0.068) cent/unit higher than shipping prices during non-promotion periods in promotion markets compared with non-promotion markets, estimated by the short-panel (long-panel) data. The results indicate that intertemporal arbitrage between promotion and non-promotion periods, and spatial arbitrage between promotion and non-promotion markets were nearly efficient. Nevertheless, supply to promotion markets or during the promotion periods may not have adjusted perfectly, such that promotions generated slightly higher, but not statistically significant, shipping price in promotion market during promotion period.

How retailers set retail prices in response to industry advertising programs is very important to the effectiveness of promotion programs. Retail prices were lower, but not statistically significant, than retail prices in non-promotional periods and in non-promotion

markets, suggested by the estimates from the short-panel and the long-panel data. Retail prices were 0.384 cent/unit lower by the estimate from the short-panel data, and were 0.150 cent/unit lower by the estimate from the long-panel data. There is no evidence that retailers capture some of the demand expansion induced by the CAC promotions through higher retail prices and some very weak evidence that they may contribute to the effectiveness of the programs by lowering price.

As noted, retailers usually make ex-ante pricing decisions. Retailers, according to Lal and Matutes, may offer price discounts in response to an anticipated demand shock. Retailers, therefore, may reduce retail prices and margins in response to the demand shocks generated by the industry promotion programs only if they are well informed about the advertising campaigns, and they believe that the CAC's promotions will effectively increase demand for avocados. A lack of response in retail pricing to the demand shocks generated by the CAC's promotions does not necessarily suggest 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. Therefore, the CAC's promotion program could possibly be enhanced if the CAC improves communication with retailers about its advertising campaigns.

## **8 Conclusions**

Retail prices for avocados exhibited countercyclical movements over seasonal demand shocks for avocados associated with some holidays and events. Demand for avocados is significantly high during some holidays and events, in particular during Super Bowl Sunday, Christmas/New Year, and Cinco de Mayo. However, retail prices and margins were significantly low during these holidays and events, which is a behavior that is not supported by perfect competition or

standard oligopoly models. Retail prices varied differently from shipping prices during these holidays and event. Holidays and events that are associated with high demand for avocados generally had no significant effects or had positive effects on shipping prices.

The empirical results support the prediction by Lal and Matutues (1994) that retailers offer advertised sales for a product during its demand peaks to increase consumers' store patronage and profit from consumers' whole shopping basket. The evidence does not support alternative explanations proposed by Bernheim and Whinston (1990), Warner and Barskey (1995), or Nevo and Hatzitaskos (2006). The conclusions reached by this study are consistent with the conclusions by Chevalier, Kashyap, and Rossi (2003) that is based on a very different type of retail data.

How retailers adjust prices in response to demand shocks has important implications for an industry's promotion program. The results show that the CAC's promotions were associated with higher retail sales for avocados, but the evidence on significance of the promotion effects is mixed. Promotion effects estimated by the long-panel data were greater and statistically significant compared with the estimate by the short-panel data that was not statistically significant. This may be because variation in promotion variable is not sufficient for identification in the estimation by the short-panel data, which only included two years, a period when promotion expenditure did not vary much.

There was no indication that retailers capture some of the demand expansion induced by the CAC promotions through higher retail prices. There was some weak evidence that retailers may contribute to the effectiveness of the promotion programs by lowering prices, as retail prices were lower, but not statistically significant, than retail prices in non-promotional period and in non-promotion markets.

In addition, the estimation results from the shipping price model suggest that grower-shippers were able to arbitrage efficiently in response to shocks generated by the CAC's promotions. Since retail prices did not change significantly in response to the CAC's promotions, demand increase should fully pass on to the farm gate, and the farm price increases as a result. In the event that retailers reduced retail prices for avocados in response to the CAC's promotion programs, the effects of the CAC' promotions would be augmented by additional increase in quantity demanded for avocados due to retailers' price response. This study suggests a new empirical framework of promotion evaluation at the disaggregate level by utilizing natural experiment design, panel models, and econometric techniques that isolate unobserved factors that may contribute to changes in demand.

## Reference

- Anderson, T.W. and Cheng Hsiao (1982) “Formulation and Estimation of Dynamic Models Using Panel Data,” *Journal of Econometrics* 18(1): 47–82.
- Arellano, Manuel and Stephen Bond (1991) “Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations,” *Review of Economic Studies* 58: 277–297.
- Baum, Christopher, Mark Schaffer, and Steven Stillman (2003) “Instrumental variables and GMM: Estimation and testing,” *Stata Journal* 3(1): 1–31.
- Baum, Christopher, Mark Schaffer, and Steven Stillman (2007) “ivreg2: Stata module for extended instrumental variables/2SLS, GMM and AC/HAC, LIML and k-class regression,” <http://ideas.repec.org/c/boc/bocode/s425401.html>.
- Bernheim, B. Douglas and Michael D. Whinston (1990) “Multimarket Contact and Collusive Behavior,” *The RAND Journal of Economics* 21(1): 1–26.
- Cameron, Colin and Pravin Trivedi (2005) *Microeconometrics: Methods and Applications*. New York: Cambridge University 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.
- Hansen, Lars P. (1982) “Large Sample Properties of Generalized Method of Moments Estimators,” *Econometrica* 50(4): 1029–1054.
- Hosken, Daniel and David Reiffen (2004) “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. (2005) *The Economics of Commodity Programs: Lessons from California*, Peter Lang Publishing.
- Lal, Rajiv and Carmen Matutes (1994) “Retail Pricing and Advertising Strategies,” *Journal of Business* 67(3): 345–370.
- MacDonald, James (2000) “Demand, Information, and Competition: Why Do Food Prices Fall at Seasonal Demand Peaks?” *Journal of Industrial Economics* 48 (1): 27–45.
- Nevo, Aviv and Konstantinos Hatzitaskos (2006) “Why Does the Average Price Paid Fall during High Demand Periods?” working paper, Department of Economics, Northwestern University.
- Roodman, David (2006) “How to Do xtabond2: An Introduction to ‘Difference’ and ‘System’ GMM in Stata,” Working Papers 103, Center for Global Development.
- Rotemberg, Julio J. and Garth Saloner (1986) “A Supergame-Theoretic Model of Price Wars during Booms,” *American Economic Review* 76(3): 390–407.



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

Windmeijer, F. (2005) “A Finite Sample Correction for the Variance of Linear Efficient Two-step GMM Estimators,” *Journal of Econometrics* 126: 25–51.

**Table 1: Estimation Results for the Retail Pricing Model**

Dependent var.:	Short Panel				Long Panel			
	Within		FD		Within		FD	
Retail price (cents/unit)	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Retail price								
t -1	0.55***	(0.02)	0.41***	(0.04)	0.61***	(0.02)	0.50***	(0.03)
t -2	0.04*	(0.02)	-0.02	(0.03)	0.09***	(0.02)	0.04***	(0.01)
t -3	0.11***	(0.01)	0.06***	(0.02)	0.09***	(0.01)	0.06***	(0.01)
t -4	0.04***	(0.01)			0.03***	(0.01)		
t -5	0.01	(0.01)			0.02**	(0.01)		
t -6	0.04***	(0.01)			0.04***	(0.01)		
Shipping price								
t	0.07**	(0.03)	0.06*	(0.03)	0.03**	(0.01)	0.01	(0.02)
t -1	0.12***	(0.03)	0.16***	(0.04)	0.06***	(0.01)	0.06***	(0.02)
t -2			0.03	(0.03)				
t -3			0.10***	(0.03)	-	-		
Promotion (\$1000)	-0.01	(0.02)	0.03***	(0.01)	-0.02	(0.22)	0.35**	(0.16)
Mexican Imports (1000,000 lbs.)	-	-	-	-	-0.07	(0.04)	-0.01	(0.01)
Christmas /N.Y.	-5.66***	(1.09)	-4.20***	(1.14)	-2.56***	(0.59)	-2.50***	(0.72)
Super Bowl	-18.83***	(2.21)	-25.86***	(2.95)	-9.96***	(1.25)	-13.51***	(1.64)
Valentine/President	0.00	(1.44)	-6.43***	(2.25)	0.91	(0.65)	-2.06**	(0.99)
Cino de Mayo	-15.52***	(1.91)	-14.10***	(2.06)	-12.11***	(1.31)	-11.47***	(1.44)
Easter	3.67***	(0.96)	4.87***	(1.59)	2.47***	(0.63)	3.59***	(1.01)
Memorial Day	-1.16	(1.30)	-5.77***	(1.78)	-1.41**	(0.63)	-4.38***	(1.08)
July 4 <sup>th</sup>	5.44***	(1.00)	1.01	(0.94)	0.61	(0.53)	0.11	(0.67)
Labor Day	-3.48***	(1.24)	-3.74**	(1.55)	0.52	(0.62)	-0.69	(0.80)
Thanksgiving	1.85*	(1.13)	1.98	(1.37)	1.36**	(0.62)	1.97**	(0.91)
Jan.	6.33***	(1.06)	3.35***	(0.66)	6.00***	(0.92)	2.77***	(0.62)
Feb.	5.22***	(1.16)	7.35***	(1.08)	3.01***	(1.00)	3.98***	(0.77)
Mar.	3.56***	(0.93)	0.86	(0.67)	3.73***	(0.93)	1.08	(0.67)
Apr.	1.56	(1.17)	-1.01	(0.87)	1.86*	(1.09)	-1.15	(0.88)
May	8.41***	(1.49)	7.57***	(1.15)	7.43***	(1.17)	6.15***	(0.87)
Jun.	5.31***	(1.21)	2.14***	(0.72)	5.59***	(1.10)	1.70**	(0.75)
Jul.	-0.60	(1.22)	-0.88	(0.78)	0.37	(1.07)	-0.65	(0.68)
Aug.	-1.67	(1.24)	0.05	(0.74)	-1.86	(1.19)	-0.41	(0.60)
Sep.	-0.90	(1.65)	3.89*	(2.13)	0.28	(1.10)	0.99	(0.91)
Nov.	2.22*	(1.36)	2.06*	(1.09)	-3.00***	(1.19)	-1.09	(0.85)
Dec.	1.81	(1.15)	0.79	(0.96)	0.17	(1.00)	-1.17*	(0.64)
Constant	-3.26***	(0.88)	-1.04*	(0.63)	1.02	(2.02)	1.54***	(0.58)
Centered R <sup>2</sup>	0.585		-		0.857		-	
# of obs.	14473		14077		39320		37723	
# of cluster	147		147		164		164	
Min. obs./cluster	6		2		59		22	
Max. obs./cluster	112		110		412		408	
Avg. obs./cluster	98.5		95.76		239.76		230.02	
# of IVs	43		46		114		115	
# of excl. IVs	0		4		0		6	

Notes:

1. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% level, respectively.
2. Standard errors are reported in the parentheses. Standard errors are cluster-robust, i.e., standard errors are robust to heteroskedasticity and arbitrary patterns of autocorrelation within individuals by clustering at the individual level.
3. The Hansen  $J$  test statistic and the  $C$  test statistic are cluster-robust. Various weak identification test statistics that are distributed as  $F$  or  $\chi^2$  are also cluster-robust.
4. Centered  $R^2$  is not reported for the IV estimation.
5. The estimation results are for the models estimated by the short-panel or the long-panel data for large and small avocados.
6. Measurements of variables:
  - Retail price, shipping price, and retail margin are weekly and in cents/unit.
  - Retail sales are weekly and in 1000 units.
  - Import volumes of Chilean and Mexican avocados are monthly and in 1,000,000 pounds.
  - Shipment volume is weekly and in 1,000,000 units.
  - Promotion expenditure for the short-panel data is weekly and in \$1000; the promotion variable for the long panel data is a dummy variable.
7. Year-monthly dummies are generated by year dummies, monthly dummies, and dummies of interacted terms by both. For models using year-monthly dummies, the estimates for year dummies and monthly dummies are reported, but the estimates for the interacted terms are not reported.
8. The within models are estimated by mean-differenced variables. Dummy variables are not differenced in the within models. Dummy variables, avocado imports, and promotion expenditure are not transformed by first differencing in the FD models.

**Table 2: Estimation Results for the Retail Sales Model**

Dependent var.: Retail sales (1000 units)	Short Panel Data				Long Panel Data			
	Within		FD		Within		FD	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Price (cents/unit)								
t	-0.44***	(0.12)	-0.45***	(0.08)	-0.33***	(0.06)	-0.38***	(0.07)
t-1	0.11**	(0.06)	0.06***	(0.02)	0.06**	(0.03)	0.04*	(0.02)
t-2	0.13***	(0.03)	0.05***	(0.02)	0.07***	(0.01)	0.05***	(0.01)
Elasticity at means								
t	-1.82		-1.83		-1.36		-1.58	
t-1	0.50		0.25		0.27		0.16	
t-2	0.51		0.21		0.28		0.21	
Promotion (\$1000)	0.02	(0.07)	-0.005	(0.02)	2.11*	(1.18)	0.39*	(0.24)
Christmas /N.Y.	7.06***	(1.82)	3.29**	(1.59)	5.01***	(1.05)	2.73**	(1.19)
Super Bowl	17.59***	(3.86)	13.42***	(3.21)	8.18***	(1.79)	12.33***	(2.42)
Valentine/President	0.73	(1.21)	4.77**	(2.03)	-0.16	(0.63)	3.50**	(1.47)
Oscar Awards	1.29	(1.25)	2.71	(1.81)	0.15	(0.63)	0.57	(1.15)
Cino de Mayo	4.52**	(2.11)	5.82***	(1.92)	5.49***	(1.26)	10.46***	(2.20)
Easter	1.52	(1.40)	0.64	(1.29)	2.68**	(1.14)	2.17**	(1.08)
Mother's Day	-1.20	(1.50)	-2.73	(2.23)	-0.61	(0.93)	-5.89***	(1.86)
Memorial Day	2.70*	(1.45)	2.71	(1.48)	2.86***	(1.12)	5.16***	(1.70)
Father's Day	-3.52	(3.24)	-0.59	(3.48)	-0.76	(0.56)	-0.02	(1.29)
July 4 <sup>th</sup>	4.11***	(1.35)	3.71***	(1.07)	3.80***	(1.09)	4.54***	(1.27)
Labor Day	5.19***	(1.70)	6.86***	(2.36)	2.21***	(0.68)	3.94***	(1.14)
Thanksgiving	-1.51	(2.93)	-1.93	(1.20)	-0.93	(1.00)	0.12	(0.90)
Jan.	-1.53	(1.18)	-1.24	(0.79)	-4.19***	(1.23)	-2.28***	(0.62)
Feb.	-1.60	(1.34)	-3.30***	(1.11)	-2.81***	(1.14)	-2.76***	(0.86)
Mar.	-0.64	(1.44)	-0.40	(0.60)	-1.71*	(1.00)	-0.08	(0.57)
Apr.	-0.29	(1.50)	-0.07	(0.60)	-1.29	(1.08)	-0.85*	(0.51)
May	3.68***	(1.39)	-0.47	(1.07)	3.08***	(1.08)	-1.25*	(0.75)
Jun.	7.74**	(3.16)	0.39	(1.12)	3.67***	(0.99)	-0.33	(0.49)
Jul.	0.00	(1.41)	-0.78	(0.60)	2.77***	(0.82)	-1.37***	(0.46)
Aug.	1.17	(1.50)	-0.68	(0.64)	1.36*	(0.80)	-0.45	(0.35)
Sep.	4.34***	(1.63)	-1.16	(0.76)	1.03*	(0.57)	-0.76*	(0.41)
Nov.	1.57	(1.75)	0.78	(0.74)	-0.35	(0.71)	-0.40	(0.53)
Dec.	-1.21	(1.75)	-0.25	(1.17)	-2.05**	(0.94)	0.32	(0.76)
Constant	-4.11***	(1.35)	-0.33	(0.48)	-0.18	(1.99)	-0.53**	(0.23)
# of obs.	13886		13886		37000		37000	
# of cluster	147		147		164		164	
Min obs./cluster	1		1		12		12	
Max obs./cluster	109		109		406		406	
Avg. obs./cluster	94.46		94.46		225.61		225.61	
# of IVs	46		36		45		44	
# of excl. IVs	17		6		10		9	

Notes: See notes at the end of table 1. The average retail price and sales are \$1.3438/unit and 32898 units for the short panel data, and \$1.3407/unit and 32189 units for the long panel data.

**Table 1: Estimation Results for the Shipping Price Model**

Dependent var.: Shipping price (cents/unit)	Short panel, weight average shipping price for CA and imported avocados				Long panel, shipping price for CA avocados			
	Within		FD		Within		FD	
	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
<b>(1) weekly</b>								
Shipment volume (1,000,000 units)	-6.35***	(1.10)	-2.05***	(0.59)	-0.30	(1.16)	-2.05***	(0.87)
Promotion (\$1000)	0.01	(0.02)	-0.02***	(0.01)	0.06	(0.39)	-0.08	(0.05)
Mexican Imports (1,000,000 lbs.)	-0.46***	(0.07)	-0.02***	(0.01)	-0.17***	(0.05)	-0.02	(0.02)
<b>(2) year-monthly</b>								
Shipment volume	-7.39***	(1.22)	-3.05***	(0.74)	-0.72	(1.20)	-2.95***	(0.85)
Promotion	0.01	(0.02)	-0.03***	(0.01)	-0.04	(0.37)	-0.10**	(0.05)
Mexican Imports	-0.46***	(0.07)	-0.07***	(0.01)	-0.14***	(0.04)	-0.02	(0.02)
<b>From (2):</b>								
Christmas	3.15***	(0.46)	0.88	(0.55)	-7.08***	(0.54)	0.09	(0.67)
F1	2.81***	(0.41)	2.57***	(0.75)	-4.86***	(0.51)	-1.52	(0.93)
New Year	-2.65***	(0.48)	0.29	(0.72)	-3.81***	(0.38)	0.10	(0.46)
Super Bowl	0.59	(0.37)	-3.74***	(0.50)	0.28	(0.34)	-2.17**	(0.35)
F1	0.50	(0.50)	-0.96	(0.88)	-0.10	(0.34)	-0.30	(0.37)
Easter	-0.05	(0.30)	0.14	(0.34)	1.66***	(0.19)	0.88**	(0.25)
F1	0.22	(0.31)	-0.06	(0.44)	0.83***	(0.18)	1.08**	(0.26)
Cino de Mayo	-1.39**	(0.69)	-0.01	(0.87)	0.71***	(0.23)	0.02	(0.29)
F1	1.65***	(0.59)	1.79***	(0.54)	2.01***	(0.18)	0.74**	(0.28)
Memorial Day	5.69***	(0.64)	0.43	(0.66)	1.10***	(0.31)	1.66**	(0.29)
F1	2.76***	(0.52)	-0.76	(0.78)	-0.12	(0.16)	0.49	(0.28)
July 4 <sup>th</sup>	2.35***	(0.29)	-1.81***	(0.44)	-1.08***	(0.15)	-0.56**	(0.16)
F1	-2.56***	(0.56)	-4.80***	(0.49)	-0.83***	(0.26)	-2.11**	(0.20)
Labor Day	0.10	(0.54)	-3.11***	(0.64)	0.05	(0.27)	0.86*	(0.35)
F1	-1.27***	(0.39)	0.41	(0.46)	1.70***	(0.23)	1.05**	(0.24)
Thanksgiving	-2.31***	(0.40)	3.17***	(0.83)	-5.48***	(0.82)	-1.81	(1.06)
F1	-6.01***	(0.73)	4.10***	(0.78)	-3.24***	(0.70)	-0.49	(0.79)
Centered $R^2$	0.604		0.082		0.734		0.099	
# of obs.	8525		8454		23721		23687	
# of cluster	77		77		77		77	
Min obs./cluster	35		34		52		52	
Max obs./cluster	117		116		417		416	
Avg. obs./cluster	110.75		109.79		308.06		307.51	

Note: See notes at the end of table 1.

**Table 4: Seasonal Effects of Retail Sales**

Dependent var.: Retail sales (1,000 units)	Within				FD			
	Short Panel		Long Panel		Short Panel		Long Panel	
	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.
Christmas /New Year	7.06***	(1.82)	5.01***	(1.05)	3.29**	(1.59)	2.73**	(1.19)
Super Bowl Sunday	17.59***	(3.86)	8.18***	(1.79)	13.42***	(3.21)	12.33***	(2.42)
Valentine/President Day	0.73	(1.21)	-0.16	(0.63)	4.77**	(2.03)	3.50**	(1.47)
Academy Awards	1.29	(1.25)	0.15	(0.63)	2.71	(1.81)	0.57	(1.15)
Cincode Mayo	4.52**	(2.11)	5.49***	(1.26)	5.82***	(1.92)	10.46***	(2.20)
Easter	1.52	(1.40)	2.68**	(1.14)	0.64	(1.29)	2.17**	(1.08)
Mother's Day	-1.20	(1.50)	-0.61	(0.93)	-2.73	(2.23)	-5.89***	(1.86)
Memorial Day	2.70*	(1.45)	2.86***	(1.12)	2.71	(1.48)	5.16***	(1.70)
Father's Day	-3.52	(3.24)	-0.76	(0.56)	-0.59	(3.48)	-0.02	(1.29)
July 4 <sup>th</sup>	4.11***	(1.35)	3.80***	(1.09)	3.71***	(1.07)	4.54***	(1.27)
Labor Day	5.19***	(1.70)	2.21***	(0.68)	6.86***	(2.36)	3.94***	(1.14)
Thanksgiving	-1.51	(2.93)	-0.93	(1.00)	-1.93	(1.20)	0.12	(0.90)
Christmas /New Year								
Large avocados	3.11***	(2.27)	4.35***	(1.13)				
Small avocados	10.81***	(3.35)	5.74***	(1.71)				
H <sub>0</sub> : Large = Small								
F(1, #)	F(1,146) = 2.99		F(1,163) = 0.51					
Prob.	0.09		0.48					
Super Bowl Sunday								
Large avocados	16.98***	(5.96)	7.41***	(2.55)				
Small avocados	17.92***	(5.70)	8.96***	(2.59)				
H <sub>0</sub> : Large = Small								
F(1, #)	F(1,146) = 0.01		F(1,163) = 0.18					
Prob.	0.92		0.67					
Cinco de Mayo								
Large avocados	7.31**	(3.08)	5.21**	(2.40)				
Small avocados	1.69	(3.02)	5.78***	(1.96)				
H <sub>0</sub> : Large = Small								
F(1, #)	F(1,146) = 1.67		F(1,163) = 0.03					
Prob.	0.20		0.87					
Jan.	-1.53	(1.18)	-4.19***	(1.23)				
Feb.	-1.60	(1.34)	-2.81***	(1.14)				
Mar.	-0.64	(1.44)	-1.71*	(1.00)				
Apr.	-0.29	(1.50)	-1.29	(1.08)				
May	3.68***	(1.39)	3.08***	(1.08)				
Jun.	7.74**	(3.16)	3.67***	(0.99)				
Jul.	0.00	(1.41)	2.77***	(0.82)				
Aug.	1.17	(1.50)	1.36*	(0.80)				
Sep.	4.34***	(1.63)	1.03*	(0.57)				
Nov.	1.57	(1.75)	-0.35	(0.71)				
Dec.	-1.21	(1.75)	-2.05**	(0.94)				

Note: See notes at the end of table 1.

**Table 5: Seasonal Effects of Retail Price**

Dependent var.: Retail price (cents/unit)	Within				FD			
	Short Panel		Long Panel		Short Panel		Long Panel	
	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.
Christmas /New Year	-5.66***	(1.09)	-2.56***	(0.59)	-4.20***	(1.14)	-2.50***	(0.72)
Super Bowl Sunday	-18.83***	(2.21)	-9.96***	(1.25)	-25.86***	(2.95)	-13.51***	(1.64)
Valentine/President Day	0.00	(1.44)	0.91	(0.65)	-6.43***	(2.25)	-2.06**	(0.99)
Cincode Mayo	-15.52***	(1.91)	-12.11***	(1.31)	-14.10***	(2.06)	-11.47***	(1.44)
Easter	3.67***	(0.96)	2.47***	(0.63)	4.87***	(1.59)	3.59***	(1.01)
Memorial Day	-1.16	(1.30)	-1.41**	(0.63)	-5.77***	(1.78)	-4.38***	(1.08)
July 4 <sup>th</sup>	5.44***	(1.00)	0.61	(0.53)	1.01	(0.94)	0.11	(0.67)
Labor Day	-3.48***	(1.24)	0.52	(0.62)	-3.74**	(1.55)	-0.69	(0.80)
Thanksgiving	1.85*	(1.13)	1.36**	(0.62)	1.98	(1.37)	1.97**	(0.91)
Christmas /New Year								
Large avocados	-6.50***	(1.49)	-2.75***	(0.79)				
Small avocados	-4.83***	(1.12)	-2.38***	(0.70)				
H <sub>0</sub> : Large = Small								
F(1, #)	F(1,146) = 1.25		F(1,163) = 0.17					
Prob.	0.27		0.68					
Super Bowl Sunday								
Large avocados	-20.03***	(3.22)	-11.52***	(1.82)				
Small avocados	-17.61***	(2.82)	-8.55***	(1.45)				
H <sub>0</sub> : Large = Small								
F(1, #)	F(1,146) = 0.34		F(1,163) = 1.93					
Prob.	0.56		0.17					
Cincode Mayo								
Large avocados	-17.25***	(2.33)	-13.25***	(1.81)				
Small avocados	-13.90***	(2.23)	-11.10***	(1.49)				
H <sub>0</sub> : Large = Small								
F(1, #)	F(1,146) = 1.77		F(1,163) = 1.14					
Prob.	0.19		0.29					
Jan.	6.33***	(1.06)	6.00***	(0.92)				
Feb.	5.22***	(1.16)	3.01***	(1.00)				
Mar.	3.56***	(0.93)	3.73***	(0.93)				
Apr.	1.56	(1.17)	1.86*	(1.09)				
May	8.41***	(1.49)	7.43***	(1.17)				
Jun.	5.31***	(1.21)	5.59***	(1.10)				
Jul.	-0.60	(1.22)	0.37	(1.07)				
Aug.	-1.67	(1.24)	-1.86	(1.19)				
Sep.	-0.90	(1.65)	0.28	(1.10)				
Nov.	2.22*	(1.36)	-3.00***	(1.19)				
Dec.	1.81	(1.15)	0.17	(1.00)				

Note: See notes at the end of table 1.

**Table 6: Seasonal Effects of Shipping Price**

Dependent var.: Shipping price (cents/unit)	Within				FD			
	<u>Short Panel</u>		<u>Long Panel</u>		<u>Short Panel</u>		<u>Long Panel</u>	
	CA & imported avocado		CA avocados		CA & imported avocados		CA avocados	
	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.
Christmas	3.15 <sup>***</sup>	(0.46)	-7.08 <sup>***</sup>	(0.54)	0.88	(0.55)	0.09	(0.67)
F1	2.81 <sup>***</sup>	(0.41)	-4.86 <sup>***</sup>	(0.51)	2.57 <sup>***</sup>	(0.75)	-1.52	(0.93)
New Year	-2.65 <sup>***</sup>	(0.48)	-3.81 <sup>***</sup>	(0.38)	0.29	(0.72)	0.10	(0.46)
Super Bowl Sunday	0.59	(0.37)	0.28	(0.34)	-3.74 <sup>***</sup>	(0.50)	-2.17 <sup>**</sup>	(0.35)
F1	0.50	(0.50)	-0.10	(0.34)	-0.96	(0.88)	-0.30	(0.37)
Easter	-0.05	(0.30)	1.66 <sup>***</sup>	(0.19)	0.14	(0.34)	0.88 <sup>**</sup>	(0.25)
F1	0.22	(0.31)	0.83 <sup>***</sup>	(0.18)	-0.06	(0.44)	1.08 <sup>**</sup>	(0.26)
Cincode Mayo	-1.39 <sup>**</sup>	(0.69)	0.71 <sup>***</sup>	(0.23)	-0.01	(0.87)	0.02	(0.29)
F1	1.65 <sup>***</sup>	(0.59)	2.01 <sup>***</sup>	(0.18)	1.79 <sup>***</sup>	(0.54)	0.74 <sup>**</sup>	(0.28)
Memorial Day	5.69 <sup>***</sup>	(0.64)	1.10 <sup>***</sup>	(0.31)	0.43	(0.66)	1.66 <sup>**</sup>	(0.29)
F1	2.76 <sup>***</sup>	(0.52)	-0.12	(0.16)	-0.76	(0.78)	0.49	(0.28)
July 4 <sup>th</sup>	2.35 <sup>***</sup>	(0.29)	-1.08 <sup>***</sup>	(0.15)	-1.81 <sup>***</sup>	(0.44)	-0.56 <sup>**</sup>	(0.16)
F1	-2.56 <sup>***</sup>	(0.56)	-0.83 <sup>***</sup>	(0.26)	-4.80 <sup>***</sup>	(0.49)	-2.11 <sup>**</sup>	(0.20)
Labor Day	0.10	(0.54)	0.05	(0.27)	-3.11 <sup>***</sup>	(0.64)	0.86 <sup>*</sup>	(0.35)
F1	-1.27 <sup>***</sup>	(0.39)	1.70 <sup>***</sup>	(0.23)	0.41	(0.46)	1.05 <sup>**</sup>	(0.24)
Thanksgiving	-2.31 <sup>***</sup>	(0.40)	-5.48 <sup>***</sup>	(0.82)	3.17 <sup>***</sup>	(0.83)	-1.81	(1.06)
F1	-6.01 <sup>***</sup>	(0.73)	-3.24 <sup>***</sup>	(0.70)	4.10 <sup>***</sup>	(0.78)	-0.49	(0.79)
Jan.	10.33 <sup>***</sup>	(0.98)	4.48 <sup>***</sup>	(0.93)				
Feb.	7.23 <sup>***</sup>	(0.92)	3.75 <sup>***</sup>	(0.97)				
Mar.	12.07 <sup>***</sup>	(0.98)	6.50 <sup>***</sup>	(1.07)				
Apr.	9.42 <sup>***</sup>	(0.98)	2.76 <sup>**</sup>	(1.16)				
May	8.46 <sup>***</sup>	(0.94)	3.44 <sup>***</sup>	(0.92)				
Jun.	11.15 <sup>***</sup>	(0.87)	3.53 <sup>***</sup>	(0.91)				
Jul.	3.28 <sup>***</sup>	(1.16)	-2.97 <sup>**</sup>	(1.39)				
Aug.	9.92 <sup>***</sup>	(0.79)	-9.83 <sup>***</sup>	(1.46)				
Sep.	-3.86 <sup>***</sup>	(0.60)	-7.90 <sup>***</sup>	(0.87)				
Nov.	-6.38 <sup>***</sup>	(0.86)	-26.75 <sup>***</sup>	(1.75)				
Dec.	-14.63 <sup>***</sup>	(0.70)	-33.02 <sup>***</sup>	(1.58)				

Note: See notes at the end of table 1.



**Table 7: The Effect of the CAC's Promotions on Retail Sales, Retail Price, and Shipping Price**

**(a) Estimation Results**

	<u>Retail Sales</u>		<u>Retail Price</u>		<u>Shipping Price</u>	
	(1000 units, weekly)		(cents/unit, weekly)		(cents/unit, weekly)	
	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.
Short panel						
Promotion (pooled)	0.030	0.071	-0.019	0.020	0.006	0.024
Radio	0.033	0.077	-0.019	0.021	0.028	0.018
Outdoor	-0.061	0.187	-0.023	0.079	0.083	0.062
Long panel						
Promotion (pooled)	3.438***	1.386	-0.150	0.229	0.068	0.564
Radio	3.920*	2.265	0.042	0.411	0.136	0.350
Outdoor	1.903	1.387	-0.245	0.311	0.087	0.442

**(b) The Estimated Effects of the CAC's Promotions during 2003–2004**

	<u>Retail Sales</u>		<u>Retail Price</u>		<u>Shipping Price</u>	
	(1000 units, weekly)		(cents/unit, weekly)		(cents/unit, weekly)	
	2003	2004	2003	2004	2003	2004
Radio						
Radio 1	0.652	0.698	-0.369	-0.396	0.553	0.592
Radio 2	0.699	0.710	-0.396	-0.402	0.593	0.602
Radio 3	0.673	0.683	-0.382	-0.387	0.571	0.579
Radio 4	0.423	0.642	-0.240	-0.364	0.359	0.545
Average	0.612	0.683	-0.347	-0.387	0.519	0.580
Average						
Radio	0.422	0.464	-0.275	-0.303	0.147	0.161
Outdoor	0.244	0.255	-0.159	-0.167	0.085	0.089
Promotion	0.556	0.621	-0.363	-0.405	0.116	0.130