Retailer Pricing Strategies for Differentiated Products:

The Case of Bagged Salads and Lettuce

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I Introduction

The food retail market is characterized by a large degree of price dispersion instead of the "law of one price". Empirical studies, such as Pesendorfer (2002), Sexton, Zhang, and Chalfant (SZC, 2003), and Hosken and Reiffen (2004a, 2004b), document a remarkable degree of cross-sectional price dispersion among food retailers within a SMSA and intertemporal price variations for a given retailer. However, variations in retail prices seem loosely related to changes in wholesale prices (MacDonald, 2000; Chevalier, Kashyap, and Rossi, 2003; SZC, 2003; Hosken and Reiffen, 2004a, 2004b). The isolation of retail price setting from cost factors is magnified by temporary price reductions, which are a very important aspect of retail pricing (Hosken and Reiffen, 2004a). Empirical evidence suggests that temporary price reductions mainly reflect changes in the retail margins (i.e., sales) rather than changes in costs (MacDonald, 2000; Chevalier, Kashyap, and Rossi, 2003; SZC, 2003; Hosken and Reiffen, 2004a, 2004b). Theories, such as those developed by Salop and Stiglitz (1977, 1982), Varian (1980), Sobel (1984), Lal and Matutes (1994), and Hosken and Reiffen (2001, 2004b), explain retail price dispersion and the sale phenomenon as the result of retailers being able to price discriminate. However, many important aspects of retail pricing still remain unexplained (Hosken and Reiffen, 2004a).

The primary goal of this paper is to study retailer pricing behavior, in particular temporary price reductions and sales, for differentiated products. It is a common observation that only a small fraction of numerous goods carried by retailers are offered at low "sale" prices each week, and those selected items tend to change from time to time. Hosken and Reiffen (2004a) find that the typical grocery product has a "regular" price, and that most deviations from the regular price are downward and short-lived. They also show that temporary price reductions account for 20 to 50 percent of annual variations in retail prices for most grocery items. Prior studies suggest that temporary price reductions are attributable to retailer sale strategies, which result in decreases in margins rather than decreases in costs (MacDonald, 2000; Chevalier, Kashyap, and Rossi, 2003; SZC, 2003; Hosken and Reiffen, 2004a, 2004b). We define a sale as a special form of temporary price reduction, when the retail margin for a product decreases when the retailer reduces the product's price. [1,2]

In differentiated product markets, a product category usually comprises a number of substitute subcategories and/or brands. Empirical evidence suggests that retailer pricing behavior differs across brands within a product category (Agrawal, 1996; SZC, 2003; Hosken and Reiffen, 2004b). We study retailer pricing behavior for bagged salads. Driven by consumers' demand for convenience, variety, and quality, the bagged salad market has become highly differentiated. The bagged salad market consists of four subcategories, and three major national brands and private labels. Calvin *et al*. (2001) report that 55 firms sold 197 bagged salad items in mainstream supermarkets in 1993, with total sales of $197 million. In 1999, 54 firms sold 459 items, with sales of $1.3 billion. SZC (2003) show that retailers set prices of different brands differently for iceberg-based bagged salads, and there is no evidence of coordination among retailers in setting prices. Their empirical evidence also suggests a nearly complete absence of a

[1] We define that sales occur only when retail prices decrease. This excludes the cases where the retail price of a product remains unchanged when its purchasing price increases, or where the increase in the retail price of a product is less than the increase in its purchasing price.
[2] Studies, such as Hosken and Reiffen (2001, 2004a, 2004b) and Pesendorfer (2002), consider temporary price reductions the same as sales. They define that a temporary price reduction or a sale occurs when the retail price of a product is more than 10 or 20 percent off its regular price.

relationship between the farm-level price for iceberg lettuce and retail prices for iceberg-based bagged salads.

Models, such as those developed by Lal and Matutes (1994), Agrawal (1996), Lal and Villas-Boas (1998), and Hosken and Reiffen (2001, 2004b), explain the sale phenomenon as the result of retailer strategic behavior (e.g., retailer strategies to price discriminate). We draw empirical implications from various theories of retailer sale strategies, in particular those for differentiated products, and trade practices in the bagged salad market. One of the questions we will analyze is the extent to which temporary price reductions are the result of changes in the retail margins, rather than changes in costs. Factors that potentially explain temporary price reductions will be examined. In particular, cost variations are distinguished from other factors associated with retailer sale strategies, such as product popularity and retail competition. We look into the frequency and the depth of temporary price reductions and sales using retailer scanner data provided by Information Resource Inc. (IRI).

Prospective contributions of the present study are the following: First, most empirical studies on retailer pricing behavior, such as Giulietti and Waterson (1997), Chevalier, Kashyap, and Rossi (2003), and Hosken and Reiffen (2001, 2004a, 2004b), have emphasized broad product categories. Retailer pricing behavior for differentiated products, the focus of the present study, has heretofore received little attention. Second, although various studies have reached the conclusion that temporary price reductions and sales are important aspects of retailer pricing behavior, few have formally modeled retailers' decisions on temporary price reductions and/or sales. Third, retailer pricing behavior for storable goods has been widely analyzed, but behavior for perishable products has been little explored, and understanding retailer pricing strategies for these products has particular interest to agricultural producers.

In the following section, we summarize empirical implications from various theories of retailer sale strategies and trade practices in the bagged salad market. The empirical framework is presented in section two, followed by discussion of the data in the last section.

II Empirical Implications from Retailer Pricing Theories and Industry Trade Practices

Attempts have been made in the marketing and economics literature to explain the sale phenomenon. First, Lal and Matutes (1994) and Hosken and Reiffen (2004b) predict that the products that are more popular are more likely to be on sale than other products. The more popular products are interpreted as those with higher demands (Lal and Matutes, 1994; Chevalier, Kashyap, and Rossi, 2003; Hosken and Reiffen, 2004b). Lal and Matutes (1994) develop a model to analyze the optimal pricing and advertising policies by multiproduct retailers. They focus on the markets where demands for different products are independent of each other but are linked through consumers' one-stop shopping. Lal and Matutes suggest that holding the number of advertised products fixed, the items appealing to a broad range of consumers are more likely to be on sale and advertised in order to attract consumers into the store. Hosken and Reiffen (2004b) extend Lal and Matutes' analysis by introducing three products, two of them substitutes, and the third with demand independent of the other two. They define that the more popular products are those with higher market shares. Hosken and Reiffen predict that there should be considerable variations in the sale frequency within a group of substitute products, and the more popular items are on sale more frequently. MacDonald (2000), Chevalier, Kashyap, and Rossi (2003), and Hosken and Reiffen (2004b) study retailer pricing behavior for broad product categories. They find that retail prices are lowest during periods of peak demand, which supports Lal and Matutes' prediction about the positive relationship between product popularity and its probability of being on sale. Hosken and Reiffen (2004b) further show that within a product category, the sale probabilities for substitute products are positively correlated to the market shares of the products.

Second, retail competition and retailers' characteristics are potentially important factors that influence retailers' sale decisions. In the models of Lal and Matutes (1994) and Hosken and Reiffen (2004b), retailers' motivation to conduct sales and advertising is that retailers compete with each other for consumers' store patronage. Lal and Villas-Boas (1998) study retailer price promotions and manufacturer trade deals in the markets where retailers maximize profits of a product category that comprises multiple brands. First, the model implies that competition between retailers is the fundamental driver for retailer sale strategies. The model indicates that the primary goal of price reductions by retailers is to attract consumers who travel around stores seeking the best deals (store switchers) rather than consumers who switch between brands (brand switchers). Second, the authors conclude that promotions across brands are not independent. When price promotions are applied, promotions across brands can be either positively correlated, i.e., retailers conduct deep or light price promotions for all the brands in the category, or negatively correlated, i.e., retailers always heavily promote one brand at one time. The market structure determines the promotion pattern.[3] In the case where consumers' shopping decision is dominated by choice in stores rather than choice in brands (i.e., there are no consumers who travel around stores to buy the preferred brand at the lowest price), retailers cut price of one brand at one time, and the promoted brand is the lowest priced brand. We can expect that this situation is plausible for bagged salads. Moreover, Lal and Rao (1997) and Boatwright, Dhar, and Rossi (2004) suggest that retailers' characteristics, such as Hi-Lo-Pricing or Every-Day-Low-Pricing store formats, are important factors that explain retailer pricing strategies.

Third, substitution patterns between brands may affect retailers' sale decisions. Lal and Villas-Boas (1998) did not model the differences in brands (the brands in their model are symmetric), e.g., the stronger brand that has a higher consumer loyalty requires smaller discounts to attract the loyal consumers of the weaker brand to switch than the weaker brand does (Raju, Srinivasan, and Lal, 1990; Agrawal, 1996). However, we can expect that substitution patterns between brands, and/or the differences in the degree of loyalty across brands could have an impact on retailers' sale decisions. Agrawal (1996) shows that a monopoly retailer promotes the stronger brand more often but provides a smaller price discount for it compared to the weaker brand. In contrast, Lal and Villas-Boas (1998) predict that retailers do not conduct price discounts in the absence of retail competition. It is not easy to obtain an appropriate and consistent measurement for the "strength" of different brands. Instead, we will study retailer pricing strategies for national brands and private labels by assuming that national brands are stronger relative to private labels. Narasimhan (1988), Raju, Srinivasan, and Lal (1990), Rao (1991), and

[3] The market structure is determined by the relative sizes of the various market segments in terms of loyalty to manufacturers, retailers, or manufacturer-retailer pairs.

Agrawal (1996) predict that retailers are least motivated to conduct price promotions for private labels and tend to keep them at stable low prices.

Fourth, demand and cost variations that potentially explain temporary price reductions will be analyzed, in particular demand and supply seasonality and changes in the farm-level prices for lettuce. Lettuce production and shipments are concentrated in California and Arizona. Nearly all the lettuce consumed in the U.S. is produced domestically. Nearly 97 percent of lettuce was produced in California and Arizona during 1992 and 1999 on average. All the leading bagged salad manufacturers have processing plants in California. Further, California-based shippers constitute virtually the entire population of lettuce shippers that supply the domestic U.S. market (Glaser, Thompson, and Handy, 2001). Therefore, we can examine the effects of changes in lettuce prices at the farm level on changes in the prices for lettuce and bagged salads at the retail level. Further, we will investigate whether and how retailer pricing behavior varies for lettuce, and national brands and private labels of bagged salads. Glaser, Thompson, and Handy (2001) suggest that trade practices between shippers and retailers for bagged salads have effectively muted the transmission of seasonal supply shocks from the farm level to the retail level compared to lettuce. Moreover, the length and characteristics of marketing channels differ between lettuce and bagged salads and between national brands and private labels of bagged salads. These differences could influence retailer pricing strategies for these products.

III Retailer Pricing Behavior for Bagged Salads and Lettuce

1. The data

Our empirical analysis is based on the retailer scanner data provided by Information Resources Inc. (IRI) and the shipping-point price information available from the USDA Federal-State Market News Service (F-SMNS). The retailer scanner data include weekly data on varieties of head lettuce and bagged salads for twenty retail accounts in six U.S. cities from January 1998 through December 1999. A retail account is defined as a particular market-retailer combination, e.g., retailer 1 in Chicago. Bagged salads are organized by universal product classification (UPC) codes, and head lettuce products are recorded by price lookup (PLU) codes. For each account and each UPC or PLU code, IRI provided weekly volume and dollar sales, retail prices, and the number of stores within the chain selling the product in the city.

Bagged salads consist of traditional iceberg-based salads, various salad blends featuring a combination of lettuce types, salad kits containing both fresh-cut salads and salad dressing, and organic salads. Iceberg-based salads and salad blends are included in our study.[4] We analyze three major national brands—Dole, Fresh Express, and Ready Pac, and private labels, which accounted for more than 90 percent of the market share in 1999 according to Calvin *et al*. (2001) and our data. An unbranded product, fresh cut salads carried by two retail accounts, is considered. It accounted for over 70 percent of stores sales. Lettuce, iceberg, romaine, red leaf and green leaf, are also included in our analysis. Lettuce will provide helpful comparison, in that lettuce is relatively

[4] Salad kits are not analyzed in the study for the following reasons. Products in the salad kit category changed frequently during the study period, which incurred series issues of missing values. Furthermore, product description of many UPC codes of salad kits are missing and cannot be found. Therefore, it is difficult to deal with such codes without basic information, such as size and ingredients.

homogenous and close to the raw agricultural product compared to bagged salads, and trade practices between shippers and retailers and retailer pricing strategies are different between lettuce and bagged salads (Glaser, Thompson, and Handy, 2001; SZC, 2003).

The weekly shipping point prices on varieties of lettuce are obtained from USDA F-SMNS. Price information on five major varieties, iceberg, romaine, red lead, green leaf, and Boston lettuce, are used to capture the changes in retail purchasing costs. We do not have information on purchasing prices at the retail level, which are confidential and may differ across retailer due to the specific contracts between retailers and grower/shippers. Glaser, Thompson, and Handy (2001) and crop profile information from the USDA Regional IPM Centers Information System suggest that majority of lettuce are sold through contracts rather than in terminal wholesale markets.[5] In addition, lettuce is highly perishable. It typically takes three to six days for lettuce to be harvested in the field to be on shelves in supermarkets in the U.S. according the crop profiles. Shipping-point prices represent open (spot) market sales by first handlers on product of generally good quality and condition unless otherwise stated.[6] The truck rates remained quite stable during the study period according the information from USDA Agricultural Marketing Service (AMS). Therefore, shipping-point price could capture changes in the retail purchasing costs.

We construct shipping-point price series for each one of retail products in our analysis. There are 49 UPC codes for bagged salads, and 4 PLU codes for lettuce. In particular, the average shipping-point prices of lettuce are according to product

[5] The crop profiles for varieties of lettuce are available from http://www.ipmcenters.org/cropprofiles.
[6] Shipping-point prices may include promotional allowances or other incentives. No consideration is given to after-sale adjustments unless otherwise stated. Brokerage fees paid by the shipper are included in the price reported.

ingredients. California produces approximately 72 percent of the iceberg lettuce and 81 percent of leaf lettuce (including romaine, red leaf, green leaf, and Boston lettuce) grown in U.S. California and Arizona account for approximately 98 percent of iceberg production and 97 percent leaf lettuce production in U.S. Production in Arizona occurs primarily between late December and early March, when production in California is low. Arizona provides as much as 85 percent of the lettuce for U.S. markets during the winter months. Thus, price information on lettuce shipped from Arizona is used during the winter months, and price information on lettuce shipping from California is used during the rest of the year. Particular timing differ across different varieties of lettuce.

2. Characteristics of retailer pricing behavior for bagged salads and lettuce

Table 1 reports the overview statistics of retail prices and shipping-point prices by category and brand. Prices are measured by $/unit for bagged salads, and $/head for head lettuce both at retail and shipping-point level. For iceberg-based bagged (IBB) salads, mean prices for Dole and Fresh Express are close and at a higher level compared with those for Ready Pack, private labels, and fresh-cut IBB salads. Retail prices for three national brands vary to larger extent relative to those for private labels and fresh-cut IBB salads. Fresh-cut IBB salads have the least variations in bagged salad category. Statistics for fresh-cut IBB salads are similar to those for iceberg head lettuce. Retail prices of salad blends for national brands are less variable than those for private labels. There are more variations in retail prices for IBB salads than those for salad blends. Volume shares of IBB salads account for 78 percent of bagged salads (salad kits are excluded) according to our data. This may suggest that the price variability of IBB salads is attributable to retailers' sales strategies, i.e., putting production with high demand on sales to attract customers into the store (Lal and Matutues, 1994; Hosken and Reiffen, 2001, 2004b). Furthermore, retail prices for private label and fresh-cut IBB salads have a lower mean and variance than those for national brands. This may support the prediction by Narasimhan(1988), etc, which predicts that retailers would set price for private labels at lower stable level.

Lettuce prices at the shipping point account only 15 to 27 percent of retail prices. The four statistics of retail prices for lettuce and fresh-cut IBB salads are approximately proportionate to the four statistics of shipping-point prices for lettuce. This may suggest that retail prices for fresh-cut IBB salads and lettuce move with shipping-point prices for lettuce.

Table 2 reports the number of observations within certain categories, the percentage of observations at, above, and below the annual mode. It also reports the number of observations that were above (below) annual modal price by 10 or 20 percent. An annual mode is computed for every one UPC or PUL code carried by each retailer for each year. Twenty-three to forty-five percent of time, retail prices for salads are at their annual modes (expect for fresh-cut IBB salads, and private label salad blends. If retail prices are away from their mode, they tend to go downward by 53 to 85 percent of time. In particular, the variation that retail prices are off annual model prices by 20 percent, accounts for 10 to 69 percent of annual retail price variation. On the contrary, shipping-point prices are not at their annual prices most of the time. When they are away from the annual modal prices, they changes to both directions more symmetrically. We define a temporary price reduction occurs when retail price of a product is below it annual modal price by at least 10 or 20 percent.

The last column of lower panel in table 2 reports the volume sales of each category in total salad volume sales. Although lettuce has larger shares than bagged salads, retail prices remain more stable than retail price for bagged salads. For IBB salads, brands that have higher market shares tend to more temporary price reduction. However, private labels with the smallest market shares of salad blends have the most frequent temporary price reductions.

The patterns of temporary price reductions are further illustrated in Figure 1, where four panels display histograms for retail price indices and shipping-point prices. The definition of retail price indices is defined by the ratio of retail price over it annual modal prices, followed by Hosken and Reiffen (2004a). The general information remains, a) retail prices are at annual modal prices to a large extent, b) retail prices for bagged salads have tendency to decrease, c) national brands engage in more price variations (downward) in more popular product categories, while brands with smaller market shares more likely to conduct price reductions for the less popular products.

The above discussion is based on product categories. Sexton, Zhang, and Chalfant (2003) show that there is a large degree of retail price heterogeneity for IBB salads across retailers within a market area. Table 3 reports summary statistics of retail prices for IBB salads at UPC level and retail prices for lettuce in Los Angeles. The product category and the market chosen represent the general pattern of retailer pricing behavior revealed for other products and in other markets. First, retailers differentiate themselves via product choice. Notice that none of the retailers have the same set of brands and product lines. The means and standard deviations are close for the same product sold at different retail accounts. Therefore, we further examine the correlations of the same price series presented n table 3. Table 4 reports the correlations of retail prices between brands and between retail stores, the correlations of retail prices between bagged salads, lettuce, and the correlations between retail prices and shipping-point prices. The shaded numbers are the correlations between retail prices of the products sold by the same retailer. The bolded numbers are the correlations between retail prices of the same brand, or the same size. Retail prices for bagged salads are less correlated with other prices series, such as retail prices of other IBB product sold by the same retailer, retail prices of the same product sold by other retailers, retail prices of the same brand or same size, lettuce prices, and shipping-point prices. Surprisingly, sixteen out of twenty-six price correlations between retail prices for bagged salad and shipping-point prices are negative. However, in the lower panel of table 4, it shows that retail prices for lettuce are higher correlated with each, and they are positively correlated with shipping-point prices to considerable extent.

IV Empirical Models

We apply both a retailer pricing model and models for retailers' sales decision to examine both changes in mean levels of retail prices, and changes in variability of retail prices. A retail pricing model is applied to examine how cost variations and common shocks affect retail prices. Retailers' decisions on temporary price reductions will be modeled in terms of product choice (i.e., which product to offer a discount) and the depth of price discounts (i.e., how much to discount). Sources that may explain retail price variability are decomposed into one associated with retailer sale strategies and the other related to cost variations.

1. A retailer pricing model

Let product i belong to subcategory *s* and brand *b*, and account *a* denote a city-chain pair, e.g., Los Angeles-Albertsons. Retailer prices are postulated as a function of shipping-point prices, seasonal shocks, unobserved retailer and city-specific characteristics, and unobserved brand, categorical, or idiosyncratic product characteristics. A retailer pricing model can be written as

(1) $p_{iat} = \alpha_a + \alpha_i + \alpha_t + \beta_2 w_{i,t} + \varepsilon_{iat}$

where p_{iat} is the price of product i sold at retail account at week. Each retail account-product combination comprises a price series. There are 375 price series in the sample, and each one of them has more than 60 observations during 1998—1999 (104 observations in total). $w_{i,t}$ denotes the weekly shipping-point prices for corresponding lettuce products and bagged salad items at the retail level. ε_{iat} is the error terms, which are assumed to be heterskedastic with mean zero and different variance for each price series. Further, we allow cluster at the market level and allow the error terms of price series with in the same market area to be correlated. αs and βs are the parameters to be estimated. α_a is a vector of account fixed effects. α_i is a vector of dummies for product at UPC level, which can be decomposed to broader brand and subcategorical representation. α_t is a vector of time-related control variables including yearly, monthly, and holiday dummies.

We further examine the seasonal patterns of shipping-point prices by estimate shipping point prices as a linear function of time-related dummy variables. This helps to understand the seasonal patterns (if any) of retail prices.

2. Retailers' choice for temporary price reductions

A logit model for the probability of temporary price reductions/sales is applied to analyze retailers' decisions on temporary price reductions/sales with respect to product choice. Retailers' decision on which product to offer a discount/sale fits naturally into discrete choice models that describe decision makers' choices among alternatives. Consider a pooled estimation for the probability of temporary price reductions for all the retailers in all the cities Account *a*'s decision on offering product *i* a temporary price reduction in week *t* can be described by

(2) $I_{iat} = \eta_a + \eta_i + \eta_t + \gamma_1 Popularity_{i,city} + \gamma_2 FOB_{i,t} + e_{iat}$

where I_{iat} equal to one indicates that account *a* conducts a price discount for product *i* in week *t*, otherwise I_{iat} equal to zero. $Popularity_{i,city}$ denotes the market share of product *i* in a given city. The market shares are calculated as the share of volume sales of product *i* with respective to volume sales of salads including bagged salads and lettuce for each quarter. The original measurements are units, i.e., bags for bagged salads, and heads for lettuce at both retail and shipping-point levels. Unit sales are converted to volume sales by pounds according to the product description for bagged salads, and according to packing rules (data description) for lettuce by USDA –SMNS. The error term has the same structure assumed in the retailer pricing model, except that we assume its distribution is extreme value by logit.

The following discussion is applied for both retailer pricing models and the model for retailers' sales decision. First, consider retailers' decisions on temporary price reductions in response to demand and cost variations. Seasonality is introduced by monthly and holiday dummies to account for seasonal demand and supply shocks. The farm-level prices for lettuce and their lags are also included, considering the possible lagged response of retail prices to changes in the farm-level prices. If temporary price reductions reflect changes in costs, or changes in the farm-level prices effectively pass through to retailers, we expect β_3 to be negative implying the probability of temporary price reductions is higher when the farm-level prices for lettuce are lower. Otherwise, we suggest that temporary price reductions do not reflect decreases in costs.

Second, if the sale probability is positively correlated to product popularity as predicted by Lal and Matutes (1994) and Hosken and Reiffen (2004b), we expect monthly dummies in summer and holiday dummies to be positive.[7] Sales comprise a subset of temporary price reductions. Therefore, the probability of temporary price reductions is higher when the sale probability is higher. If the probability of temporary price reductions is not related to cost variations, and it is higher during periods of peak demand, we suggest that temporary price reductions reflect changes in the retail margins, i.e., retailer sale strategies, rather than changes in costs.

Third, a second regression can be conducted to estimate group-specific β_3 for lettuce ($\beta_{3,l}$), and private labels ($\beta_{3,p}$) and national brands ($\beta_{3,n}$) of bagged salads by leaving out a brand specialized in organic salads (Earthbound Farm). If $\beta_{3,l}$ and/or $\beta_{3,p}$ are negative, and $\beta_{3,n}$ is not significant different from zero; or if all of the three parameters are negative, and $\beta_{3,l}$ and/or $\beta_{3,p}$ are significantly larger in absolute value terms than $\beta_{3,n}$,

[7] Demands for bagged salads were high during May and September, and peaked in May and/or August in five of the six cities according to our data.

we suggest that changes in the farm-level prices for lettuce contribute more to temporary price reductions for lettuce and/or private-labels of bagged salads than those for national brands of bagged salads.

Further, we will look into other factors that explain temporary price reductions as the result of retailer sale strategies. First, if a product's sale probability is higher when the product is more popular as predicated by Lal and Matutes (1994) and Hosken and Reiffen (2004b), we expect β_1 to be positive. Second, another regression will be applied to obtain group-specific β_1 for lettuce ($\beta_{1,l}$), and private labels ($\beta_{1,p}$) and national brands ($\beta_{1,n}$) of bagged salads. We expect $\beta_{1,n}$ to be positive, and the dummy variable for private labels to be negative. Narasimhan (1988), Raju, Srinivasan, and Lal (1990), Rao (1991), and Agrawal (1996) predict that retailers are least motivated to conduct price promotions for private labels compared to national brands. Therefore, the unobserved characteristics of private labels except for their market shares are expected to have negative effects on their sale probability. Further, $\beta_{1,l}$ is expected to be positive and larger than $\beta_{1,n}$, since lettuce is more popular than bagged salads according to the data.[8] Otherwise, we would expect that other factors, such as the differences in product and market channel characteristics, might explain the difference in retailer pricing strategies between lettuce and bagged salads.

The theoretical literature on price promotions [e.g., Varian (1980), Lal and Matutes (1994), Lal and Villas-Boas (1998), and Hosken and Reiffen (2001, 2004b)] emphasizes competition between retailers as the fundamental driver of sales. However, these theories do not provide explicit implications for the relationship between the degree of competitiveness in the retail market and the sale probability. Both the Herfinahl index

[8] SZC (2003) find that retail prices for iceberg lettuce have smaller variance than retail prices for iceberg-based bagged salads, and some stores tend to maintain very stable lettuce prices.

and its squared term are included to capture the first- and second-order effects of retail competition. Further, the chain size of each account and account fixed effects are included to capture the observed and unobserved account characteristics. We expect the coefficients of account characteristics to be significantly different from zero, implying that retailers' characteristics have significant effects on retailer pricing strategies.

3. Depth of temporary price reductions

Retailers' decisions on temporary price reductions about how much to discount can be evaluated by the following regression

$$\Delta P_{iat} = \theta' Z + v_{iat}\text{, where } \Delta P_{iat} = P_{iat} - P^{r}_{ia} \qquad (3)$$

Given product i is offered a temporary price reduction in week t, ΔP_{iat} is the difference between the retail price of product i at account a in week t (P_{iat}), and its regular price (P^{r}_{ia}). Explanatory variables, Z, are similar to those included in the models of retailers' decisions on temporary price reductions/sales with respect to product choice. θ denotes the parameters to be estimated.

V Results

Table 5 reports the estimation results from retailer pricing model and shipping-point price model. The models explain 58 percent of variations in retail prices, and 42 percent of variations in shipping-point prices. Shipping-point prices explain 14.8 percent changes in retail prices of salad products at 99 percent significance level. Compared to the base month—January, retail prices of salad items are significantly higher during May and July, and in December. However, shipping-point prices for lettuce are lower during the same months except in May compared to shipping-point prices in January, although none of the coefficients for these four months are statistically significant. On the other hand, retail prices in February and March (April) are not significantly different from those in January, although shipping-point prices are lower (higher) than those in January at 90 (99) percent significance level. Therefore, the estimates suggest that retail prices either do not respond to changes in shipping-point prices or move in the opposite direction of shipping-point prices.

Estimated coefficients for six out of eighteen holiday and national events are statistically significant, and five of them are positive. There are six holiday dummies statistically significant in the shipping-point price estimation, and four of them are negative. This may explained by the fact that these negative coefficients occur during the production peak season. Hence, estimated coefficients for monthly and holiday dummy variables do not support the predictions of Lal and Matutes (1994), Hosken and Reffein (2001, 2004b), and are not consistent with findings by Chevalier, Kashyap, and Rossi, (2003).

The category and brand characteristics show that IBB salads have significantly lower mean than salad blends by pair-wise F tests. The omitted group is red leaf lettuce. Retail prices are measured by \$/bag. Since most salad blend items have smaller sizes(mostly 5oz, 8oz, 12oz) than IBB salads (mostly 12 oz, 16 oz, 32 oz). The unit prices for bagged salads are much higher than those for IBB salads when taking sizes into consideration. Tests of joint equality of brand-category variables are rejected for both IBB salads and salad blends ($F(4, 5) = 614.64$, p-value=0.000 for salad blends; $F(4, 5) = 215.66$, p-value=0.000 for IBB salads). Pair-wise tests for equality of retail prices of private labels, Ready Pac, and fresh-cut IBB salads, which are lower compared to Dole and Fresh Express, do not strong support the hypothesis that private label and/or fresh-cut IBB salads have lower price levels than national brands.[9]

Table 6 reports estimation results for a Logit model for retailers' sales decision on product choice (on the left), and estimation results of a linear model for retailers' sales decision on the depth of discounts. In particular, odds ratio are reported for Logit estimates. Shipping-point prices do not statistically significant effects on product choice decision. However, once a product is chosen as a sale item, the discounts are lighter when shipping-point prices are lower. Product popularity has statistically significantly positively effects on retailers' sales decision on product choice and statistically negative effects on the extent of sales. In particular, 1.1 percent increase in market shares of a product increases the probability of putting the product on sale by one percent.

The size of a salad blend item does not matter much to retailers' sales decision, since salad blend items are usually differentiated by their contents. However, the size of IBB salads is an important factor explaining retailers' sales decision. The most popular sizes of IBB salads are medium-sizes, e.g., 12 oz and 16 oz IBB salad. The medium-size IBB salads are more frequently on sales compared with other sized items, while with mild price cuts. On contrary, IBB items with smaller or large sizes are put on sale less often then medium-size IBB items, but they received large discounts once they are on sale.

The probability of sales practices is higher during May and July, September to December. Furthermore, sales during these months are also accompanied by deeper

[9] Test results are: Ready Pac vs. private label: $F(1, 5)= 0.01$, p-value=0.929; Ready Pac vs. fresh-cut: $F(1,5)=12.76$, p-value=0.0001; private label vs. fresh-cut: $F(1,5) =0.81$, p-value= 0.409.

discounts. Recall that retail prices are significantly higher during the May and July in our retailer pricing model. This suggests that retailers may response to decrease in purchasing prices of lettuce during seasonal production peaks by increase price variability via sales practice, rather than adjust mean levels of retail prices. President Day, Veteran's Day, Easter Sunday, Independence Day, and Thanksgiving Day are associated with significantly higher sales probability of salad items, the latter three holidays also receive significantly larger discounts.

The IBB salad items are more likely to be on sales for all brands compared to salad blend items, although the depth of discounts is smaller. On the other hand, iceberg lettuce that has the largest shares of salad sales, is not more likely to be the sale item. If iceberg lettuce is on sales, the price cuts are significantly higher.

Although there are many interesting empirical findings in the logit model for retailers' sales decision on product choice, the models only explains less than tenth (R-squared is 0.091 for the Logit model, and is 0.075 for the linear model) of retailers' sales behavior in terms of product choice. There are more of retailers' pricing behavior to be understood.

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Table 1 Summary Statistics for Salad Retail Prices by Brand and Subcategories

(Prices are measured by $/unit for bagged salad, and $/head for lettuce)

Subcategory	Brand	Mean	St.d	Range	P75-P50
Bagged salads					
Iceberg-based salads					
	Dole	2.19	0.72	3.18	1.00
	Fresh Express	2.18	0.90	4.61	1.28
	Ready Pac	2.01	0.89	3.40	1.20
	Private Labels	2.00	0.62	2.26	1.10
	Fresh-cut	2.03	0.22	1.11	0.31
Salad blends					
	Dole	2.69	0.35	3.00	0.40
	Fresh Express	2.79	0.37	3.02	0.30
	Ready Pac	2.89	0.25	1.82	0.03
	Private Labels	2.62	0.60	2.98	0.48
Lettuce					
Iceberg lettuce	-	1.14	0.20	1.64	0.30
Leaf lettuce	-	1.32	0.44	2.51	0.50
Shipping-point prices					
Iceberg lettuce	-	0.24	0.11	0.54	0.10
Leaf lettuce	-	0.20	0.20	1.47	0.20

Table 2 Price Variations of Bagged Salads and Lettuce

Subcategory	Brand	# of obs	Percentage of observations =mode	>mode	<mode	
Bagged salads						
Iceberg-based salads						
	Dole	3492	22.48	13.34	72.68	
	Fresh Express	4583	28.37	17.61	60.07	
	Ready Pac	1028	39.59	25.1	53.7	
	Private Labels	729	24.42	11.8	63.79	
	Fresh-cut	208	1.92		98.08	
Salad blends						
	Dole	7368	24.12	13.55	68.28	
	Fresh Express	7329	45.27	21.12	55.49	
	Ready Pac	3303	42.87	8.81	53.19	
	Private Labels	3027	13.02	6.44	85.73	
Lettuce						
Iceberg lettuce	-	1556	20.57	36.44	42.99	
Leaf lettuce	-	4648	27.43	33.24	39.33	
Shipping-point prices						
Iceberg lettuce	-	104	5.77	30.77	63.46	
Leaf lettuce	-	416	10.58	47.6	41.83	
Subcategory	Brand	>mode, by 10%	20%	<mode, by 10%	20%	**volume shares**
Bagged salads						
Iceberg-based salads						
	Dole	2.81	1.12	13.29	8.99	**9.83**
	Fresh Express	5.96	3.82	18.39	10.3	**6.74**
	Ready Pac	5.06	2.33	8.07	7.39	**4.48**
	Private Labels	2.47	0.14	10.84	8.09	**1.39**
	Fresh-cut			67.79	27.4	**8.35**
Salad blends						
	Dole	6.73	5.48	13.44	8.47	**2.09**
	Fresh Express	3.34	0.22	11.87	8.6	**3.09**
	Ready Pac	1.48		11.35	7.69	**2.11**
	Private Labels	0.56		20.48	10.11	**1.36**
Lettuce						
Iceberg lettuce	-	15.17	11.25	16.58	8.8	**38.37**
Leaf lettuce	-	17.04	11.79	11.81	7.12	**22.06**
Shipping-point prices						
Iceberg lettuce	-	19.23	12.5	57.69	44.23	
Leaf lettuce	-	39.66	31.25	31.25	24.28	

Note: Bagged salads and head lettuce are sold by units by retailers. We convert unit sales to volume sales measured by pounds according to production description and suggestions from crop profiles provided by USDA.

Table 3 Summary Statistics for Retail Prices in Los Angeles

(Prices are measured by $/unit for bagged salad, and $/head for lettuce)

	Brand	subcategory	measure	mean	St.d	range	p75-p59
Retailer 1							
bagged salad	Dole	IBB	12oz/unit	1.81	0.27	1.05	0.40
	Fresh-cut	IBB	32oz/unit	2.08	0.17	0.82	0.27
lettuce		iceberg	head	1.08	0.23	1.64	0.18
		romaine	head	1.09	0.32	1.91	0.03
Retailer 2							
bagged salad	Dole	IBB	12oz/unit	1.96	0.10	0.50	0.01
	Dole	IBB	16oz/unit	1.63	0.15	0.70	0.02
	Dole	IBB	32oz/unit	2.38	0.20	0.55	0.02
lettuce		iceberg	head	0.95	0.15	1.01	0.05
		romaine	head	1.02	0.19	1.29	0.02
Retailer 3							
bagged salad	Dole	IBB	12oz/unit	2.02	0.15	0.72	0.00
	Dole	IBB	16oz/unit	1.58	0.11	0.40	0.20
	Dole	IBB	32oz/unit	2.69	0.01	0.12	0.00
	Ready Pac	IBB	12oz/unit	1.78	0.25	0.52	0.50
	Ready Pac	IBB	16oz/unit	1.59	0.10	0.40	0.20
	Ready Pac	IBB	32oz/unit	2.64	0.17	0.71	0.01
lettuce		iceberg	head	1.03	0.18	0.97	0.03
		romaine	head	1.08	0.23	1.18	0.01
Retailer 4							
bagged salad	Ready Pac	IBB	16oz/unit	1.63	0.12	0.78	0.20
	Ready Pac	IBB	32oz/unit	2.67	0.12	0.79	0.00
lettuce		iceberg	head	1.03	0.20	0.93	0.02
		romaine	head	1.07	0.27	1.70	0.06
Shipping-point							
		iceberg	head	0.24	0.11	0.54	0.10
		romaine	head	0.28	0.21	1.37	0.14

Table 4 Price Correlations in Los Angeles

Retailer	Ret. 1		Ret. 2			Ret. 3						Ret. 4	
Brand	Dole	FreCut	Dole	Dole	Dole	Dole	Dole	Dole	RP	RP	RP	RP	RP
Size	12	32	12	16	32	12	16	32	12	16	32	16	32
1-DO-12	1.00												
1-FC-32	0.31	1.00											
2-DO-12	**0.05**	-0.02	1.00										
2-DO-16	0.19	0.03	0.80	1.00									
2-DO-32	0.37	**0.21**	0.23	0.43	1.00								
3-DO -12	**0.15**	-0.12	**0.08**	0.06	-0.18	1.00							
3- DO -16	0.26	0.17	0.09	**0.25**	0.51	-0.28	1.00						
3- DO -32	0.09	**-0.08**	-0.10	-0.11	**-0.17**	0.10	-0.08	1.00					
3-RP-12	**-0.08**	-0.18	**-0.03**	-0.25	-0.45	**0.25**	-0.78	0.04	1.00				
3-RP-16	0.25	0.21	0.11	**0.28**	0.56	-0.31	**0.94**	-0.12	-0.80	1.00			
3-RP-32	0.21	0.09	-0.07	-0.05	-0.14	0.07	0.14	**-0.03**	-0.23	0.16	1.00		
4-RP-16	0.19	0.08	0.07	**0.24**	0.64	-0.17	**0.34**	-0.03	-0.25	**0.37**	-0.14	1.00	
4-RP-32	-0.16	0.04	-0.02	-0.09	-0.22	0.06	-0.28	-0.02	0.29	**-0.27**	-0.04	-0.19	1.00
1-iceberg	-0.10	0.02	0.04	-0.01	-0.36	-0.08	-0.46	0.01	0.24	-0.34	0.10	-0.33	0.10
1-romaine	-0.17	-0.11	-0.13	-0.14	-0.50	0.32	-0.42	0.15	0.34	-0.39	0.13	-0.37	0.08
2-iceberg	-0.05	0.19	-0.12	-0.01	-0.23	-0.12	-0.21	0.01	0.13	-0.07	0.10	-0.21	0.10
2-romaine	-0.14	0.10	-0.45	-0.23	-0.38	0.17	-0.31	0.08	0.23	-0.25	0.06	-0.34	0.06
3-iceberg	-0.20	-0.04	-0.19	-0.16	-0.54	0.02	-0.42	0.09	0.30	-0.34	0.07	-0.41	0.14
3-romaine	-0.27	-0.14	-0.19	-0.16	-0.65	0.28	-0.39	0.19	0.31	-0.41	0.12	-0.46	0.06
shipping-point													
iceberg	-0.07	0.06	-0.11	-0.06	-0.21	-0.08	-0.31	-0.02	0.11	-0.29	0.12	-0.10	0.04
romaine	-0.24	-0.09	-0.09	-0.07	-0.42	0.03	-0.19	0.12	0.06	-0.21	0.17	-0.25	0.00

	Ret.1		Ret.2		Ret.3		shipping point	
	iceberg	romaine	iceberg	romaine	iceberg	romaine	iceberg	romaine
lettuce								
1-iceberg	1.00							
1-romaine	0.65	1.00						
2-iceberg	0.60	0.62	1.00					
2-romaine	0.53	0.70	0.75	1.00				
3-iceberg	0.76	0.86	0.72	0.74	1.00			
3-romaine	0.55	0.87	0.56	0.72	0.85	1.00		
shipping-point								
iceberg	0.59	0.45	0.36	0.32	0.45	0.37	1.00	
romaine	0.55	0.75	0.46	0.47	0.70	0.68	0.58	1.00

Table 5 Estimation Results for Retailer Pricing Model and Shipping-point Price Model

Retailer Pricing Model			**Shipping-point Price Model**		
	Coefficient	Std. Err.		Coefficient	Std. Err.
Dependent variable			Dependent variable		
retail price			shipping-point price		
Explanatory variables			Explanatory variables		
shipping-point price	0.148***	0.033			
year=1999	0.041**	0.011	year=1999	-0.086**	0.023
Month			Month		
Feb	0.032	0.022	Feb	-0.079*	0.031
Mar	0.016	0.027	Mar	-0.062*	0.027
Apr	-0.008	0.024	Apr	0.275***	0.032
May	0.053***	0.010	May	0.065	0.044
June	0.046**	0.013	June	-0.049	0.040
July	0.046*	0.021	July	-0.032	0.042
August	0.030	0.016	August	-0.002	0.038
September	0.031	0.021	September	0.079	0.057
October	0.026	0.013	October	0.063	0.056
November	0.037	0.022	November	-0.041	0.040
December	0.060**	0.020	December	-0.067	0.036
Holidays			Holidays		
Christmas	-0.036	0.040	Christmas	-0.019	0.013
New Year	0.034	0.018	New Year	0.046**	0.011
Martin Luther King	0.038	0.027	Martin Luther King	-0.009	0.010
Super Bowl	0.040*	0.018	Super Bowl	-0.077**	0.026
President Day	-0.049**	0.016	President Day	-0.006	0.021
Cino de Mayo	-0.021	0.014	Cino de Mayo	0.366**	0.094
Easter Sunday	0.040*	0.020	Easter Sunday	-0.062*	0.028
Mother's Day	0.037*	0.018	Mother's Day	-0.093**	0.022
Memorial Day	-0.013	0.016	Memorial Day	-0.072	0.036
Father's Day	0.001	0.013	Father's Day	-0.019	0.009
Independence Day	0.031**	0.011	Independence Day	-0.009	0.013
Labor Day	0.015	0.012	Labor Day	-0.021*	0.008
Columbus Day	-0.009	0.014	Columbus Day	0.028**	0.009
Halloween	-0.023	0.015	Halloween	0.003	0.014
Veteran's Day	0.022	0.012	Veteran's Day	-0.006	0.005
Thanksgiving	0.028***	0.007	Thanksgiving	-0.007	0.008
Product-related			Product-related		
Dole-blend	1.588***	0.077			
Dole-IBB	1.081***	0.153			
FE-blend	1.581***	0.053			
FE-IBB	0.974***	0.061			
FreCut-IBB	1.051***	0.068			
PRV-blend	1.461***	0.051			
PRV-ice	0.912***	0.159			
RP-blend	1.805***	0.065			
RP-ice	0.906***	0.048	Boston	-0.017***	0.000

iceberg	-0.096*	0.046	iceberg	-0.045***	0.000
romaine	0.016	0.016	romaine	omitted	
green leaf	-0.002	0.001	green leaf	-0.021***	0.000
red leaf	Omitted		red leaf	-0.034***	0.000
constant	1.188***	0.078	constant	0.312	0.044
Number of observations	36607		Number of observations	520	
Number of clusters	6		Number of clusters	5	
R-squared	0.583		R-squared	0.417	
Root MSE	0.508		Root MSE	0.138	

Note: One, two, and three asterisks indicate statistical significance at the 90%, 95%, and 99% level, respectively.

Table 6 Estimation Results Models of Temporary Price Reductions:

Product Choice and Depth of Discounts

Logit Model for Product Choice			**Linear Model for Depth of Discounts**		
	Odds Radio	Std. Err.		Coefficient	Std. Err.
Dependent variable			Dependent variable		
Sales			depth of discounts		
Explanatory variables			Explanatory variables		
shipping-point price	1.028	0.243	Shipping-point price	-0.010	0.018
market shares	1.089***	0.028	market shares	-0.013**	0.004
Size			Size		
Salad blend-58oz	1.316	0.601	Salad blend-58oz	0.008	0.045
Salad bland-10-12oz	1.794	0.853	Salad bland-10-12oz	-0.023	0.044
Salad blend-15oz	1.154	1.251	Salad blend-15oz	-0.019	0.103
Salad blend-24pz	1.765	1.638	Salad blend-24pz	-0.092	0.151
IBB-6oz	0.275**	0.170	IBB-6oz	0.169***	0.039
IBB-10-12oz	0.485**	0.153	IBB-10-12oz	0.077**	0.011
IBB-16oz	0.413*	0.209	IBB-16oz	0.125***	0.035
IBB-32oz	0.183***	0.078	IBB-32oz	0.155***	0.025
IBB-48oz	0.144**	0.118	IBB-48oz	0.151**	0.047
year=1999	0.898	0.115	year=1999	0.005	0.010
Month			Month		
Feb	0.897	0.170	Feb	0.039*	0.016
Mar	0.883	0.177	Mar	0.035	0.021
Apr	0.829	0.221	Apr	0.037	0.029
May	0.617**	0.126	May	0.050***	0.015
June	0.723*	0.132	June	0.048**	0.018
July	0.610*	0.168	July	0.060**	0.022
August	0.722	0.177	August	0.048**	0.020
September	0.597**	0.149	September	0.055*	0.018
October	0.637**	0.121	October	0.050**	0.015
November	0.794*	0.099	November	0.039	0.021
December	0.753**	0.097	December	0.046**	0.013
Holidays			Holidays		
Christmas	1.289	0.317	Christmas	-0.032	0.026
New Year	0.835	0.115	New Year	0.022	0.014
Martin Luther King	0.954	0.256	Martin Luther King	0.021	0.030
Super Bowl	0.921	0.190	Super Bowl	0.033	0.019
President Day	1.399**	0.230	President Day	-0.040	0.020
Cinco de Mayo	0.976	0.097	Cinco de Mayo	0.008	0.007
Easter Sunday	0.696*	0.136	Easter Sunday	0.037**	0.013
Mother's Day	0.771	0.176	Mother's Day	0.017	0.019
Memorial Day	1.188	0.157	Memorial Day	-0.001	0.012
Father's Day	0.998	0.150	Father's Day	0.003	0.015
Independence Day	0.694***	0.057	Independence Day	0.025**	0.009
Labor Day	0.938	0.106	Labor Day	0.008	0.008
Columbus Day	0.874	0.149	Columbus Day	0.010	0.013

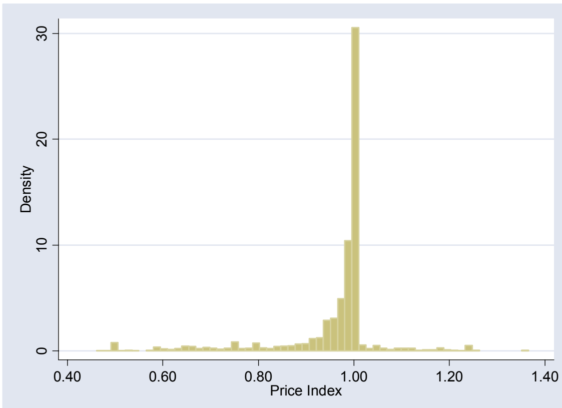
Halloween	1.065	0.137	Halloween	-0.020	0.014
Veteran's Day	0.771***	0.055	Veteran's Day	0.019	0.011
Thanksgiving	0.751***	0.052	Thanksgiving	0.025***	0.006
Product-related			Product-related		
Dole-blend	0.629	0.254	Dole-blend	-0.064	0.050
Dole-IBB	2.464*	1.162	Dole-IBB	-0.159***	0.018
FE-blend	0.594	0.227	FE-blend	-0.058	0.048
FE-IBB	4.336***	2.065	FE-IBB	-0.182***	0.032
FreCut-IBB	11.764***	7.574	FreCut-IBB	-0.174**	0.068
PRV-blend	0.938	0.348	PRV-blend	-0.055	0.034
PRV-ice	1.327	0.478	PRV-ice	-0.069***	0.007
RP-blend	0.746	0.265	RP-blend	-0.076*	0.034
RP-ice	4.596***	1.801	RP-ice	-0.189***	0.022
Iceberg	0.603	0.323	Iceberg	0.096**	0.029
Green leaf	0.566**	0.148	Green leaf	0.022	0.010
Romaine	0.900	0.362	Romaine	0.028	0.022
Number of observations	36191		Number of observations	36607	
Number of clusters	6		Number of clusters	6	
Pseudo R-squared	0.091		R-squared	0.075	
			Root MSE	0.237	

Note: One, two, and three asterisks indicate statistical significance at the 90%, 95%, and 99% level, respectively.

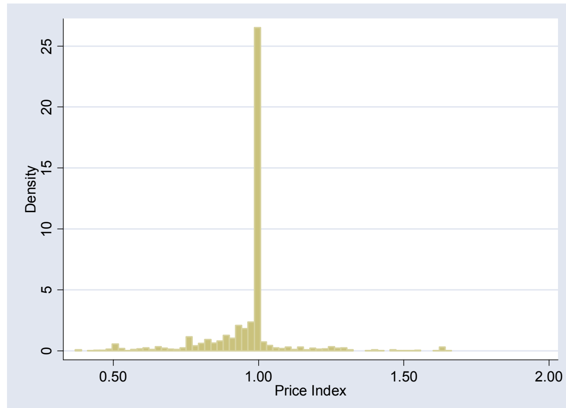
Figure 1 Histograms for Retail Price Indices and Shipping-point Prices

Panel (a) Iceberg-based bagged salads

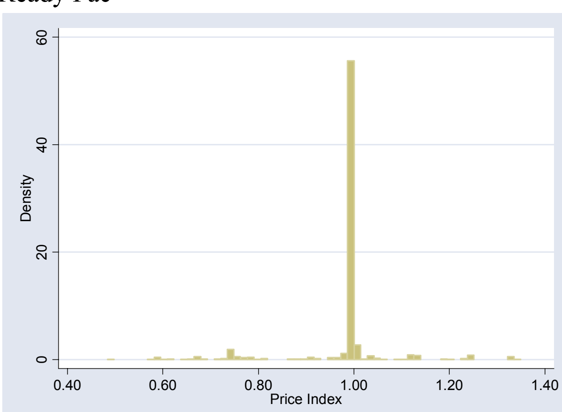
Dole



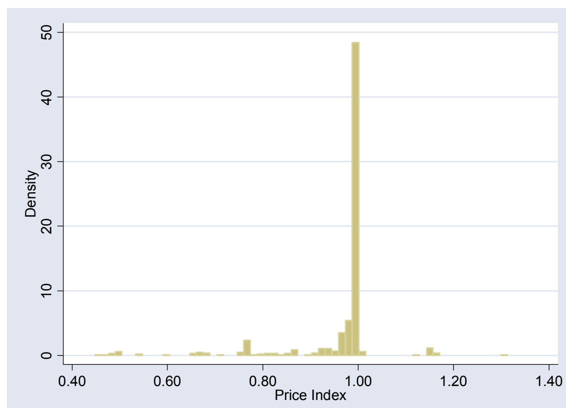
Fresh Express



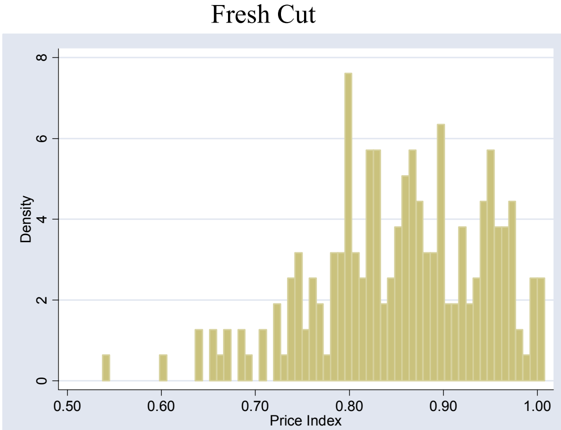
Ready Pac



Private Labels

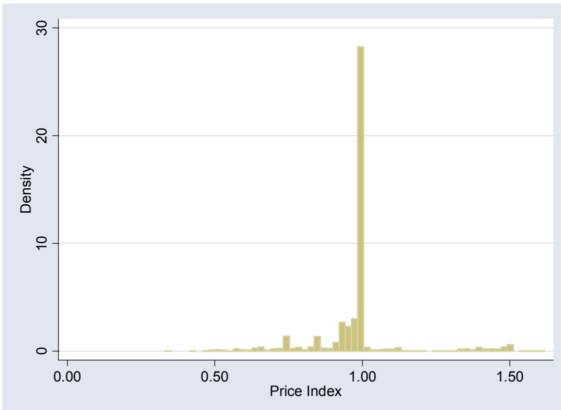


Fresh Cut

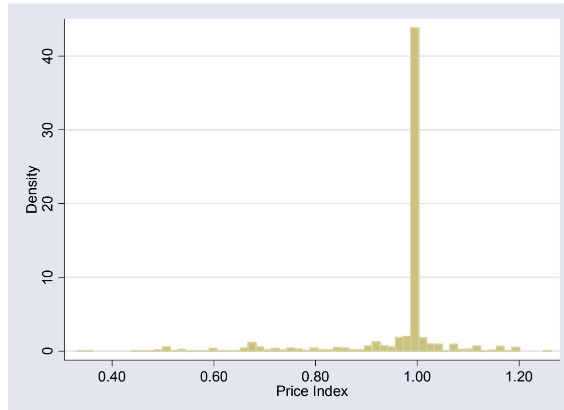


Panel (b) Salad Blends

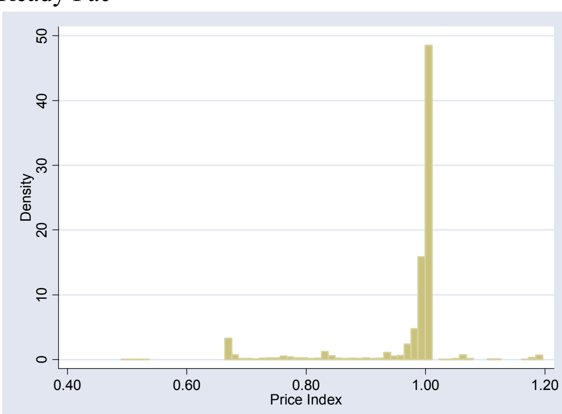
Dole



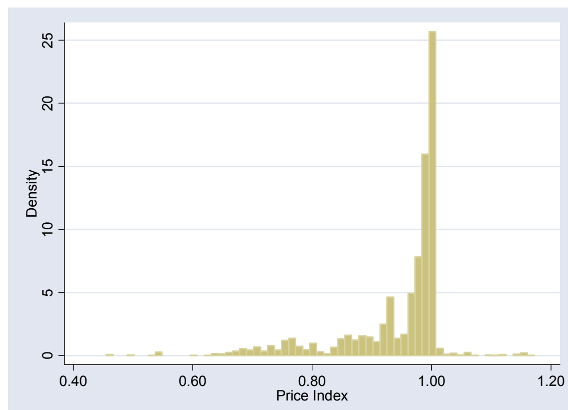
Fresh Express



Ready Pac

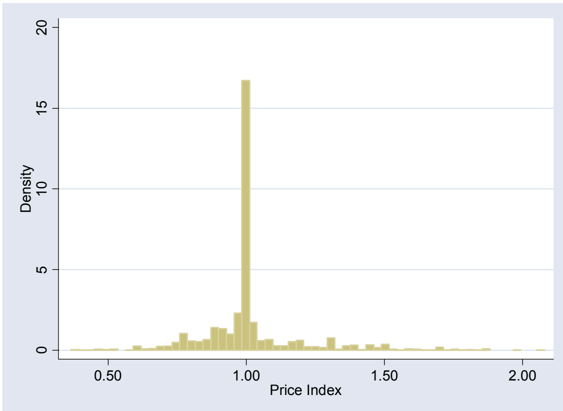


Private Labels

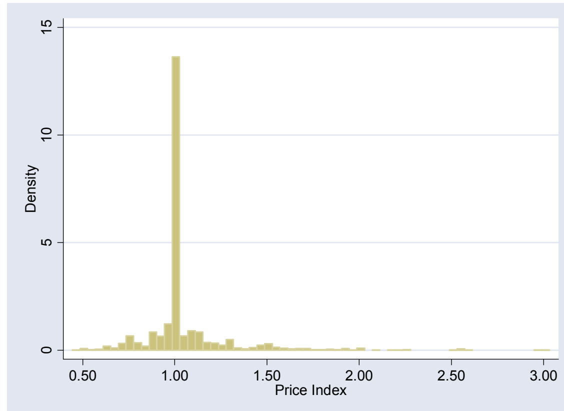


Panel (c) Lettuce at retail accounts

Head Lettuce

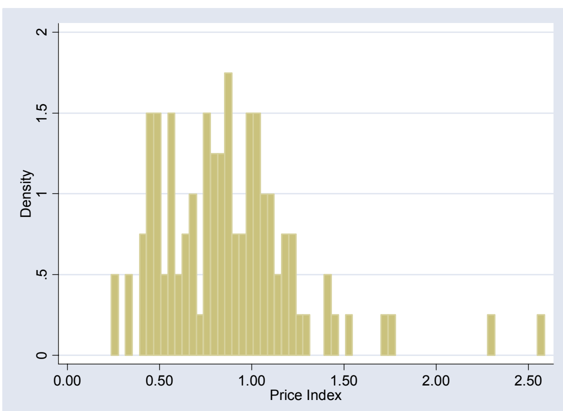


Leaf Lettuce



Panel (d) Shipping-point price for lettuce

Head Lettuce



Leaf Lettuce