The imperfect price responses of orange juice demand in the U.S.

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Abstract

The purpose of this study is to investigate imperfect price reversibility and measure price sensitivity incorporated with the effect of trade promotions for refrigerated 100% OJ. Using a price decomposition method with distributed lags, we test imperfect irreversibility and asymmetric price responses. Empirical models consisted of prices coupled with promotions and prices decoupled from promotions to determine the effect of trade promotions on retail prices. The results showed that the demand for OJ was imperfectly price reversible when we used prices coupled with promotion, and asymmetric price responses were found in NFC OJ demand. Prices coupled with promotions were more elastic than prices decoupled from promotions. The demand for OJ was influenced by both current and previous information. Dynamic adjustments toward price and promotions may result in irreversibility. Competitions with price reduction increase sales in the short run, but frequent promotions may lead to lower reference prices that eventually weaken consumer willingness to purchase at regular prices without promotions.

Key words: Asymmetry, irreversibility, promotion, orange juice.

JEL codes: L15, L66, Q13

The U.S. orange juice (OJ) market is highly competitive with over 300 orange juice brands tracked by Nielsen retail sales data. Of these brands, the top four brands accounted for approximately 75% of total sales volume in the category of refrigerated 100% OJ in 2014. Refrigerated 100% OJ consists of two types of 100% OJ, refrigerated not from concentrated (NFC) and refrigerated from concentrate (RECON). The main differences for between these two types of OJ processing recognized by consumers are taste (or quality) and price. On average, the price of NFC OJ is 1.5 times higher than RECON OJ per gallon. However, the high quality of NFC OJ has attracted consumers despite higher prices relative to RECON. In 2014, gallon sales of NFC OJ accounted for 63% of total sales of refrigerated 100% OJ and dollar sales of NFC OJ accounted for 71% of total sales.

Brand promotions of refrigerated 100% OJ are often run to encourage sales and to compete within the category. Most retail promotions are trade promotions (TP), which are promotions offered to retailers by manufacturers (Blattberg, Briesch and Fox 1995). Featured, display, and temporary price reductions (TPR) are typical types of TP. Featured advertisings are a print media on best-food-day advertisings and weekly store promotions. Displays are located within stores such as cut cases placed next to regular shelf locations. TPR is temporary price discounts. Nielsen will roll a TPR of a Universal Product Code (UPC) into the non-promotion price category after a period of approximately 6 weeks. Featured advertisings and TPR more likely entice consumers to visit stores and seek out good deals and displays potentially influence all consumers who visit stores and may cause consumer' impulse buying (Kim, Ward, and Lee 2011). Almost every week, consumers can find these promotions in grocery stores conducted by the leading brands and store brands. Nielsen's distribution indicators showed that 78% of retail stores performed feature advertising for NFC OJ on weekly basis for a given period.

Promotions are highly linked to price cuts. Compared to prices without promotion, promotions discount OJ prices up to 19% through feature advertising, 13% through display advertising, 24% through feature and display advertising and 10% through TPR. Frequent promotion, in particular promotion related to price cuts, has been shown to influence consumer reference prices (Blattberg, Briesch and Fox 1995; Kalwani et al. 1990; Krishnamurthi et al. 1992; Lattin and Bucklin 1989;Mayhew and Winer 1992) and purchase time (Krishnamurthi et al. 1992). Feature advertising may make consumers aware of 100% NFC OJ (59 fl. oz.) with a price of $3.00 (2 for $6.00), although the regular price is nearly $4.00. Consumers may delay purchases under regular prices and wait until the next promotion if they see promotions frequently. These behaviors may lead to imperfect price reversibility. Demand reductions caused by a price increase need not be completely reversed with an equivalent price decrease (Dargay and Gately 1995). Figure 1 illustrates movements of NFC and Recon OJ price and sales for specific weeks. The figure shows that sales are negatively related to price, and slopes do not appear to be same when the price increases and decreases.

<Figure 1>

The purpose of this study is to explore the existence of imperfect price responses in OJ demand and measure price sensitivity. We will compare price sensitivities from demand analysis using market prices (coupled with promotions) and prices without promotions (decoupled from promotions), focusing on two types of refrigerated 100% OJs, NFC and RECON. To the best of the authors' knowledge, this study is the first to consider prices decoupled from promotions in OJ demand analysis. Adopting Gately and Huntington's (2002) price decompositions, irreversible models were performed to test imperfect price reversible and asymmetric responses to price increase and decrease. This study helps manufacturers to understand how the retail market or consumers respond to price changes and promotions.

Literature Review

Economists have long been interested in explaining irreversibility in demand. Nerlove (1958) explained three reasons for distributed lags by taking account of irreversibility: 1) psychological, 2) technological, and 3) institutional. Analogously, Dargay (1990) explained irreversibility in terms of dynamic adjustment and asymmetry resulting from non-linearity. Both shifting/tilting in the demand curve and asymmetric price responses can cause irreversibility. If the shift in the demand curve is independent of prices, the price elasticity remains unchanged, but dynamic adjustment must enter the analysis. Assumptions of the occurrence of asymmetry distinguishes jagged ratchet and ratchet models. The jagged ratchet model is a type of Wolfram's (1971) model in which asymmetric movements happen when prices increase or decrease. The ratchet model is a type of Trail, Colman and Young's (1978) model in which asymmetric movement holds when prices rise above their previous maximum levels. That is, Trail, Colman and Young (1978) assumed that the effect of price increases and decreases are equal, while Wolfram assumed that the effect of price recovery and the effect of prices hitting their maximum historical prices are equal. When modeling asymmetric price responses, upward/downward price elasticity will be different. Gately (1992) separated price decompositions into three parts - maximum price, price cut, and price recovery - to generalize the two approaches and test conditions in which asymmetries can occur.

Dargay and Gately (1995) applied the three price decomposition methods to oil demand in the Organization for Economic Cooperation and Development (OECD). Gately and Huntington (2002) further developed three price decompositions from Gately (1992) by including initial prices in the decomposition. In both studies, the demand model was followed by the Koyck lags, dynamic process assuming geometrically declining weights for the effects of prices and income. Since the Koyck lags induce the model form to autoregressive, they used a two-stage procedure to estimate the model. Instead of the Koyck lags, we used Almon’s (1965) polynomial distributed lags (PDL) to avoid autoregression.

Studies about the effect of price and adverting on OJ sales have been conducted by several researchers (Brown 2008; Brown and Lee 1997 and 2007a; Capps, Bessler and Williams 2004; Kim, Ward and Lee 2011; Lee and Brown 2009). Both demand system models and single equation models incorporating advertising variables are popularly used to measure price elasticities of own and cross effect and advertising effect on sales. Overall, OJ price elasticity ranges from -0.57 to -3.28, and varies by types of juice, brands, models, other covariates and data frequency. Price sensitivity for NFC OJ is generally higher than RECON OJ (Brown and Lee, 2000) but it varies by markets (Brown and Lee 2007b). Brown and Lee (2007a) showed that the effect of advertising was the greatest when feature, display and TPR advertisings were performed at a same time. Lee and Brown (2009) showed that the effect of feature only advertising (the elasticity of feature only advertising was 0.0856) was greater than display only advertising (the elasticity of display only advertising was 0.0158). Also, TV advertising delivering health and nutrition messages positively influenced OJ sales (Brown and Lee 1999). Demand analysis in the studies assumed that market sales symmetrically responded to price changes, and the studies used market prices calculated from total dollar sales and total volume sales. Since the market prices are coupled with promotions, in particular price-cut promotions, the model may reflect promotions twice.

Orange juice demand model of imperfect price reversibility

In this study, we assume that the demand for OJ is a function of its own price, retail promotions, and seasonality. Following Gately and Huntington's (2002) original form, the relationship can be written as a double-log functional form.

$$q_t = \alpha + \beta p_t + \gamma z_t + \delta s_t + \varepsilon_t \quad (1)$$

where subscript t indicates a time period; q_t is the OJ sales in log of quantity; p_t is the log of the unit price; z_t is the log of promotion measurements; and s_t is seasonality. Eq. (1) assumes that OJ sales symmetrically respond to price changes. Adopting Gately and Huntington's (2002) price decomposition, the price can be rewritten as follows:

$$p_t = p_1 + p_{\max,t} + p_{cut,t} + p_{recovery,t} \quad (2)$$

where p_1 is the log of the price in starting year t=1; $p_{\max,t}$ is the cumulative increases in the log of maximum historical prices (monotonically non-decreasing, $p_{\max,t} \geq 0$); $p_{cut,t}$ is the cumulative decreases in the log of prices (monotonically non-increasing, $p_{cut,t} \leq 0$); $p_{recovery.t}$ is the cumulative sub-maximum increases in the log of prices (monotonically non-decreasing, $p_{recovery.t} \geq 0$). Substituting the decomposed price variables given in Eq. (2) into Eq. (1) and combining the constants into a single constant yields

$$q_t = \alpha^* + \beta^{\max} p_{\max,t} + \beta^{rec} p_{rec,t} + \beta^{cut} p_{cut,t} + \gamma z_t + \delta s_t + \varepsilon_t \quad (3)$$

where $\alpha^* = \alpha + \beta p_1$. The Wald test ($H_0 : \beta^{\max} = \beta^{rec} = \beta^{cut}$), the Wolffram hypothesis ($H_0 : \beta^{\max} = \beta^{rec}$) and Trail, Colman and Young's hypothesis ($H_0 : \beta^{cut} = \beta^{rec}$) (Gately 1991) can be used to test perfect reversibility.

We assume that current OJ sales are influenced by previous prices and promotions. Eq. (3) can be rewritten as

$$q_t = \alpha^* + \sum_{i=0}^{I} (\beta_i^{\max} p_{\max,t-i} + \beta_i^{rec} p_{rec,t-i} + \beta_i^{cut} p_{cut,t-i} + \gamma_i z_{t-i}) + \delta s_t + \varepsilon_t \qquad (4)$$

where i is lag terms. Adopting a quadratic lag form of the polynomial distributed lag (PDL) (Almon 1965) of the coefficient ($\beta_i = \mu_0 + \mu_1 i + \mu_2 i^2,\ \gamma_i = \xi_0 + \xi_1 i + \xi_2 i^2,\ i = 0,1,\cdots,I$, where μ_0, μ_1, μ_2, ξ_0, ξ_1 and ξ_2 are the parameters of the quadratic function describing the lag weights), Eq. (4) can be written as

$$\begin{aligned} q_t &= \alpha^* + \mu_0^{\max} P_{\max,t}^0 + \mu_1^{\max} P_{\max,t}^1 + \mu_2^{\max} P_{\max,t}^2 + \mu_0^{rec} P_{rec,t}^0 + \mu_1^{rec} P_{rec,t}^1 + \mu_2^{rec} P_{rec,t}^2 \\ &\quad + \mu_0^{cut} P_{cut,t}^0 + \mu_1^{cut} P_{cut,t}^1 + \mu_2^{cut} P_{cut,t}^2 + \xi_0 Z_t^0 + \xi_1 Z_t^1 + \xi_2 Z_t^2 + \delta s_t + \varepsilon_t \\ &\quad \text{where} \qquad (5) \\ P_{j,t}^0 &= \sum_{i=0}^{I} p_{j,t-i},\ P_{j,t}^1 = \sum_{i=0}^{I} p_{j,t-i} i,\ P_{j,t}^2 = \sum_{i=0}^{I} p_{j,t-i} i^2,\ j = \text{max, rec, cut} \\ Z_t^0 &= \sum_{i=0}^{I} z_{t-i},\ Z_t^1 = \sum_{i=0}^{I} z_{t-i} i,\ Z_t^2 = \sum_{i=0}^{I} z_{t-i} i^2 \end{aligned}$$

The optimal lags length and degree can be empirically determined based on criteria such as Akike information criterion (AIC) and Bayesian information criterion (BIC). When an optimal degree of polynomial is linear, terms with quadratic parameters disappear. Corresponding parameters of β

and γ are calculated using estimated parameters of PDL, μ and ξ, and the standard errors of the β and γ are computed from the covariance matrix of the μ and ξ using the delta method.

Data

Nielsen weekly U.S. retail OJ sales data was used for the period week ending January 5, 2013, through the week ending October 31, 2015, a total of 148 weeks. The markets included U.S. grocery stores with at least $2 million in annual sales, drug stores with at least $1 million in annual sales, mass merchandisers, supercenters, dollar stores, and military/ defense commissary agency (DeCA). Total OJ sales from the market account for approximately 55% of presumed OJ consumption in the United States (Zansler 2015).

Considering the effect of promotion on price reduction, unit prices of OJ ($/gallon) are calculated in two ways: prices coupled with promotions and prices decoupled from promotions. Prices coupled with promotions are calculated using total dollar sales and total volume sales. Therefore, prices coupled with promotions are similar to the retail prices that consumers actually paid. Prices decoupled from promotions are calculated using dollar sales not associated with any promotions and volume sales not associated with any promotions. Regular retail prices are not available from syndicated data providers such as IRI and Nielsen. Nielsen and IRI use their own algorithms to provide a 'base price' that represents prices excluding promotions. Tifaoui and von Cramon-Taubadel (2016) used filtering methods to determine the reference prices from retail prices. However, Anderson et al. (2014) pointed out that the imputation algorithms will naturally introduce some noise into the regular price variables. Unit prices are deflated using the consumer price index (CPI) to adjust for the effect of inflation. Volume sales are divided by the U.S. population to calculate per capita purchases in given periods.

We used the percent of OJ sales with retail promotions out of total OJ sales as advertising variables, following Lee and Brown (2009). Percent All Commodity Volume (%ACV) is a frequently used distribution measure of the percentage of stores selling the item and is useful in measuring distribution of products and promotions (Kim, Ward and Lee 2011; Brown and Lee 2007; Crespi and Marette 2002). However, %ACV does not cover total retailer sales because %ACV is calculated based on annual sales of stores that include some departments. Therefore, if a retailer does not have a particular department, the retailer will not be counted in %ACV. For this study, we considered trade promotions such as featured, display, combined featured and display, and TPR.

Orange juice prices and promotions in the U.S.

Table 1 includes weekly average prices and gallon sales with and without promotions. The average price coupled with promotions was $7.43 per gallon of NFC OJ and $4.82 per gallon of Recon OJ. The average price decoupled from promotions was $8.01 per gallon of NFC OJ and $5.06 per gallon of Recon OJ. Prices coupled with promotions were lower compared to prices decoupled from promotions, a discount of approximately 5% for Recon OJ and 7% for NFC OJ. Advertising related to features discounted over 20% of the price decoupled from promotions, which was a relatively high price reduction compared to display and TPR, which each reduced the price by approximately 10%. Sales of NFC OJ with promotions accounted for 45% of total NFC OJ sales. Of those, advertising related to features accounted for over 60%. Sales of Recon OJ with promotions accounted for 30% of total Recon OJ sales. Of those, TPR accounted for 45% followed by advertising related to features at 42%. These statistics indicate not only that promotions contribute highly to sales, but that retail promotions occur frequently in the OJ retail market.

<Table 1>

Price decompositions following Gately and Huntington (2002) are illustrated in Figure 2. The cumulative prices of maximum historical prices were relatively low compared to the cumulative prices of cut and recovery due to rarity of new records. The cumulative prices of cut and recovery were almost symmetric over a horizontal line indicating the high frequency of price changes. In real prices, the average market price at the ending week (October 31, 2015) of NFC OJ increased by 5.7% and the average market price of Recon OJ increased by 1.9% compared to the beginning week (January 5, 2013).

< Figure 2 >

Estimated results of imperfect price reversibility

Four empirical models were considered: 1) perfect price reversibility with prices coupled with promotions, 2) perfect price reversibility with prices decoupled from promotions, 3) imperfect price reversibility with prices coupled with promotions, and 4) imperfect price reversibility with prices decoupled from promotions. For all the empirical models, a first order autoregressive, AR(1), model was performed in order to correct for serial correlation and stabilize the time series data. The PDL structures were selected based on the AIC and BIC. Eight models (two types of OJ × four empirical models) were run with the AR(1) model incorporating degree of linear and second, and lengths of distributed lags from 2 to 5. The smallest AIC and BIC was found with the polynomial lag structure of order 2 (two lags) from five models and degree 1 (a linear form) from six models. In order to compare estimated results with the same functional forms, we applied the PDL structure of order 2 and degree 1 to all models. Actually, the PDL structure provided the second best results for the models for which it was not the best.

Tables 2 and 3 include estimated results from exact maximum likelihood estimations for the AR(1) model. The models explain approximately 88% of total variations of OJ sales. The estimated autocorrelation parameter of the residuals, ρ , are significant and satisfy the stationary assumption, $|\rho| < 1$. The augmented Dicky-Fuller (ADF) test was performed for residuals of each model to test stationarity. For all models, the t-statistics rejected the null hypothesis of unit root indicating that the final models followed white noise. Test results of Wolffram's hypothesis were not included in the tables due to insignificant estimated parameters of cumulative prices of maximum historical prices.

< Table 2>

<Table 3>

Table 2 shows the estimated results of NFC OJ. The estimated results of the model of perfect price reversibility with price coupled with promotion showed that consumer demand for NFC OJ was price sensitive. Per capita purchase of NFC OJ at time t, decreases by 1.75% when NFC OJ price at time t, increases by 1.0%. NFC OJ purchases at time=t were also influenced by the previous week's price at time t-1, while NFC OJ price from two weeks ago (at time t-2) did not significantly explain current NFC OJ purchases. The cumulative effect of NFC OJ price on NFC OJ purchase at one lag was -2.57, indicating that when the price increases by 1.0% at time t+1 as well as at time t, sales at time t+1 decrease by 2.57%. When promotion effects were controlled from retail prices, the price elasticity of NFC OJ was 0.84 and the cumulative effect of NFC OJ price on NFC OJ purchases at one lag was 1.15. Feature advertisings positively and significantly influenced NFC OJ purchases. In particular, current NFC OJ purchases were positively influenced by both current and previous feature only advertisings, while current feature and display advertising significantly influenced current NFC OJ purchases. Display advertisings and TPR did not significantly influence NFC OJ sales.

The estimated results by relaxing the assumption of perfect price reversibility showed that NFC OJ purchases significantly responded to price increase and decreases, while estimated parameters of prices hitting maximum historical prices were not significant. For an immediate effect, NFC OJ purchases increase by 1.19% when prices decrease by 1.0%., and NFC OJ purchases decrease 2.87% when prices increase by 1%. The cumulative effects at one lag were -3.02 of price-cut and -4.41 of price-recovery. For both immediate and cumulative effects, NFC OJ purchases were more sensitive to price increases than decreases. However, the test of the null hypothesis of symmetric price responses is only rejected for the cumulative effect at two lags. Estimated results from the model with price decoupled from promotions showed that the estimated parameter of price-cut was -1.20 and significant, while the estimated results of price-recovery were not significant. As with the model of perfect price reversibility, promotions related to feature advertisings significantly drove NFC OJ purchases. The test result for the hypothesis that the demand is perfectly price reversible was rejected for NFC OJ demand for the model with prices coupled with promotions, while it was not rejected when the model included prices decoupled from promotions. The result indicates that frequent promotions with price reduction may cause imperfect price reversibility in the NFC OJ market.

Table 3 shows the estimated results of four models of Recon OJ demand. From the perfect price reversibility and price coupled with promotions, we found that per capita purchase of Recon OJ decreases by 1.1%, when Recon OJ price increases by 1.0%. The cumulative effect at one lag was -

1.44 and the cumulative effect at two lags was -1.04. The price at one lag was negatively related to Recon OJ sales, while the price at two lags was positively related. Since price changes occur every 1.5 weeks on average, upward or downward price changes in two lags may impact sales in the same direction. When prices are decoupled from promotions, the price effect at one lag only significantly explained current Recon OJ purchases. Feature only advertisings and display only advertisings significantly and positively influenced Recon OJ purchases. Recon OJ purchases were also positively influenced by feature advertisings in previous weeks. Negative signs of promotion variables may be associated with high competition using different tactics. In other words, consumers will find the best deal advertised by a similar promotion, which may induce a negative sign.

Results from the imperfect price reversibility with price coupled with promotion model showed that Recon OJ purchases significantly reflected all three types of prices: maximum historical records, recovery and cut. Unlike NFC OJ, Recon OJ purchases were significantly influenced by the price hitting maximum historical records. The current effect of price-max was not significant, but Recon OJ purchases were negatively related to its lags. Although the current effect of price-cut, -1.30, was slightly greater than the current effect of price-recovery, -1.10, the long run effect (sum of lags of significant parameters) of price-recovery, -1.42, was somewhat greater than the long run effect of price-cut, -0.95. However, the Wald test of symmetric price responses failed to reject indicating that changes in Recon OJ purchases were almost equal when prices increase and decrease. When we controlled for the promotion effect in Recon OJ prices, Recon OJ purchases more closely reflected feature and display advertisings compared to price fluctuations. The hypothesis test of perfect price reversibility was rejected in both models, prices coupled with and decoupled from promotions. Also, no statistical evidence was found about asymmetric price responses.

Discussion

Our estimated results showed that NFC OJ demand was more sensitive to price changes than Recon OJ demand. High competition among NFC OJ brands, the growing popularity of NFC fruit juice and developments of new NFC juices may influence the high price sensitivity. The elastic demand of NFC OJ indicates that price-cuts may positively influence total revenue. Brown and Lee (2000) also found sensitive price responses in NFC OJ compared to Recon OJ, while Kim, Ward and Lee (2011) found that Recon OJ was more price sensitive than NFC OJ in the U.S. market with the exception of the sub-markets of the South and North-Central United States where NFC OJ was more price sensitive than Recon OJ.

Consistent with Kaul and Wittink (1995), the price elasticity of price coupled with promotion was more sensitive than the elasticity of price decoupled from promotion. Frequent promotions with price reductions strongly impacted retail price changes. Actually, Anderson et al. (2014) found that temporary sales accounted for 95% of all price changes of Tic Tac candy. Even though we can't verify the relationship between promotions and price changes due to the limited information of our data, we expect an equivalent or higher percentage can be found in refrigerated 100% OJ markets because of the high share of weekly promotion sales share and distribution. Therefore, promotions lead to decreasing prices, while no promotions lead to increasing prices.

Trade promotions significantly influenced refrigerated 100% OJ sales. In particular, consumer behavior actively reflects the feature advertising due to the high price reductions compared to other tactics such as display advertisings and TPR. Kim, Ward and Lee (2011) showed that NFC OJ purchases significantly reflected feature advertisings and Recon OJ purchase significantly reflected display advertisings in the U.S. market. Analogous with the findings, display advertising only significantly increased Recon OJ purchases but not NFC OJ purchases.

OJ sales were influenced by both current and previous prices and promotions. The immediate responses were generally greater than lagged effects. For the price effect, current prices and the price of one lagged effect significantly explained current orange juice sales. This implies that consumers refer to the price of previous weeks and use the information in their purchase decisions. That is, consumers seem to refer to recent prices rather than prices from a long time ago. This may indicate that the price from a week ago can be a useful reference price. Some marketing studies have used one-period lagged prices as reference prices (Krishnamurthi, Mazumdar and Raj 1992; Mayhew and Winder 1992).

We found significant imperfect price reversibility of NFC and Recon OJ demand from the models of price coupled with promotion. From the models of price decoupled from promotion, the model of Recon OJ demand provided significant imperfect price reversibility but not NFC OJ demand. We have not found asymmetric price responses from Recon OJ demand but the model of NFC OJ demand coupled with promotion provided significant asymmetric price responses. This indicates that asymmetric price responses may not be a major issue causing imperfect price reversibility for Recon OJ but NFC OJ. Relatively heavy promotion for NFC OJ may influence price changes in NFC OJ. Also, dynamic adjustment of demand from frequent promotions can be a possible explanation of irreversibility. Dargay (1990) mentioned that any change in the demand curve must occur at a particular instant in time or over a specified period. Of course, this relationship may be changeable depending on sample periods or other market segments. Krishnamurthi, Mazumdar and

Raj (1992) found that asymmetric price response was not significant for loyal consumers, while switchers' behaviors were significantly different when prices increase and decrease.

Early studies have indicated a long-term negative effect of trade promotion (Blattberg, Briesch and Fox 1995; Dodson et al. 1978; Strang 1975; Shoemaker and Shoaf 1977). Frequent promotions, in particular price-cuts, influence consumers' reference prices and expectation about the frequent deals. To support this, a consumer tracking survey conducted by Issues&Answers on behalf of the FDOC showed that consumers' acceptable price ranges measured by a price sensitivity meter (van Westendrop 1976) have not changed over two years (April to June 2013 and 2015), reported as between $2.99 and $3.99 for a half gallon of NFC OJ (www.fdocgrower.com/economics/consumer-research/trackers/), while market prices have increased 6.0%, during the same period.

Florida has faced a serious problem of production reduction, in particular due to citrus greening (Huanglongbring, HLB). The National Agricultural Statistics Service (NASS)/USDA forecasted that Florida orange production will be 81 million boxes in 2015/16 which is approximately 16% less than last season's production and 42% less than production five years ago, 2010/11(NASS/USDA, May 2016). Over 70% of Florida oranges are processed into chilled OJ and of them, the movement to NFC OJ accounts for over 95% (Zansler 2015).

Under the circumstance of expecting input cost increases for NFC OJ and high retail prices, low reference prices resulting from promotions may lead consumers to be less likely to purchase NFC OJ at regular prices. Also, consumers will delay their purchases when there is no promotion. Recently, leading brands have started '3 for $10.00' feature advertising. In terms of reference prices with promotions, the new plan is welcome. However, as long as other leading brands maintain '2 for $6.00', current consumer perception of OJ prices may stay near that point for the near future.

Conclusion

Price is one important factor influencing consumers' purchase decisions. Promotions with price reduction are frequently used largely due to their effectiveness. Trade promotions in the OJ market generally discounted prices by 15% compared to no promotion prices. At the same time, frequent promotions can also condition consumers to expect deal days and, as such, to selectively time their purchases. In this study, we investigated imperfect price reversibility in refrigerated 100% OJ, NFC and Recon OJ. We used a price decomposition method by Gately and Huntinton (2002) by incorporating distributed lags to test for imperfect irreversibility and asymmetric price responses. Price decoupled from promotion was also considered to determine the effect of trade promotion on retail prices.

The results showed that, while 100% refrigerated OJ demand was imperfectly price reversible when we used prices coupled with promotion, no strong asymmetric price responses were found. The demand for OJ was influenced not only by its current price and promotions, but by previous information. In comparison between NFC OJ and Recon OJ, NFC OJ demand was not imperfectly price reversible when the promotion effect was controlled from retail prices, but Recon OJ demand was still imperfectly price reversible. Relatively heavy and frequent promotions for NFC OJ may have resulted in the imperfect price reversibility. Also, dynamic adjustments reflecting market information may lead the relationship.

This study provided insight into market responses to changes in OJ prices and the frequency of promotions. Decreasing orange production and domestic OJ consumption are major issues faced by the OJ industry. Competitions with price reduction promotions increase sales in the short run, but frequent promotions may lead to lower reference prices that eventually weaken consumer willingness to purchase at regular prices without promotions.

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Figure 1. Orange juice price and sales movements in given periods

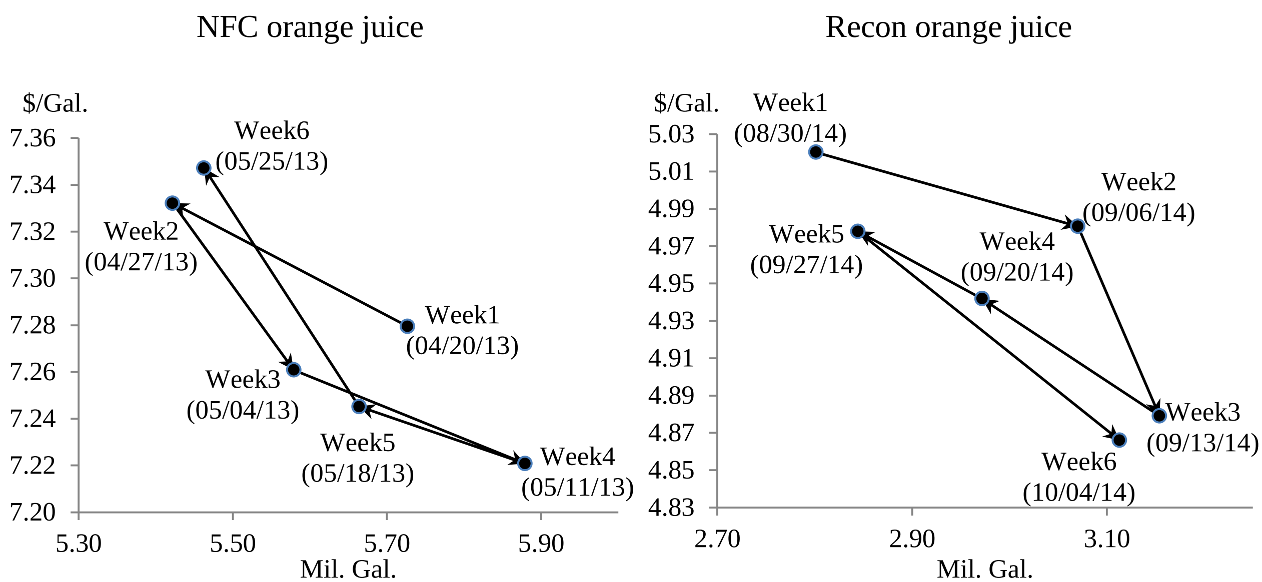
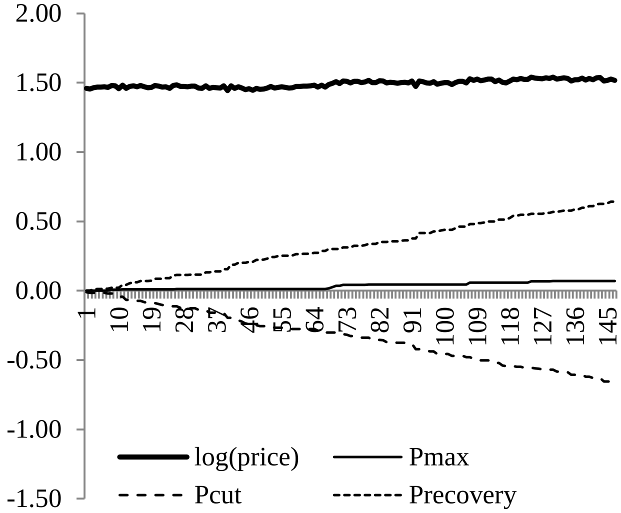


Figure 2. Weekly price trends and price decompositions using log transformed values

NFC OJ



Recon OJ

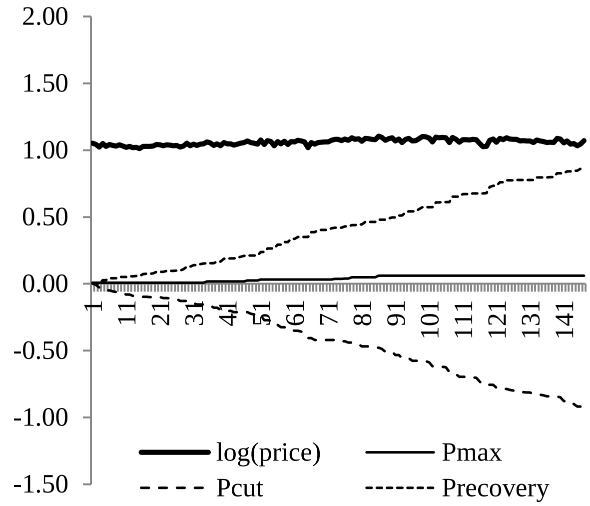


Table 1. Weekly Average of Orange Juice Prices and Gallon Sales

	Average price per gallon		% of total gallon sales	
	NFC	RECON	NFC	RECON
Total	7.43	4.82		
No promotion	8.01	5.06	55.2%	69.3%
With feature Ads	6.46	4.09	22.2%	10.6%
With display ads	7.22	4.24	2.7%	4.0%
With feature & display ads	6.21	3.80	5.2%	2.3%
With TPR	7.20	4.55	14.6%	13.8%
Gallon sales	5,645,111	3,358,769		

Table 2. Estimated Results of Demand for NFC Orange Juice

	Perfectly price reversible				Imperfectly price reversible			
	Prices coupled		Prices decoupled		Prices coupled		Prices decoupled	
	Est. Coef.	Std. Err.	Est. Coef.	Std. Err.	Est. Coef.	Std. Err.	Est. Coef.	Std. Err.
Intercept	-0.3960	(0.8788)	-1.8138**	(0.8682)	-4.0492**	(0.0349)	-3.2865**	(0.2001)
Ttrends	0.0002	(0.0003)	-0.0006	(0.0004)	0.0045	(0.0032)	-0.0010	(0.0011)
Season1	0.0478**	(0.0079)	0.0399**	(0.0071)	0.0592**	(0.0099)	0.0390**	(0.0073)
Season2	0.0801**	(0.0097)	0.0698**	(0.0086)	0.0858**	(0.0098)	0.0704**	(0.0091)
P	-1.7534**	(0.3264)	-0.8402**	(0.3827)				
P(-1)	-0.8168**	(0.2021)	-0.3123*	(0.1891)				
P(-2)	0.1198	(0.3213)	0.2156	(0.2156)				
P_max					-0.2379	(1.4633)	0.7476	(1.4861)
P_max(-1)					-0.5062	(0.3131)	-0.4788	(0.3131)
P_max(-2)					-0.7745	(1.4226)	-1.7052	(1.5804)
P_cut					-1.8352**	(0.4904)	-1.1996*	(0.6393)
P_cut(-1)					-1.1886**	(0.2973)	-0.4419*	(0.2627)
P_cut(-2)					-0.5420	(0.5367)	0.3159	(0.6432)
P_rec					-2.8705**	(0.6090)	-0.9924	(0.7516)
P_rec(-1)					-1.5429**	(0.3688)	-0.3569	(0.2724)
P_rec(-2)					-0.2152	(0.5488)	0.2785	(0.6548)
Feat. Ads			0.1815**	(0.0312)			0.1752**	(0.0322)
Feat. Ads(-1)			0.1197**	(0.0207)			0.1146**	(0.0223)
Feat. Ads(-2)			0.058*	(0.0313)			0.0540*	(0.0323)
Disp. Ads			0.0228	(0.0168)			0.0193	(0.0169)
Disp. Ads(-1)			-0.0032	(0.0087)			-0.0045	(0.0089)
Disp. Ads(-2)			-0.0293*	(0.0165)			-0.0284*	(0.0166)
Feat. & Disp. Ads			0.0643**	(0.0244)			0.0662**	(0.0251)
Feat. & Disp. Ads (-1)			0.0174	(0.0145)			0.0184	(0.0157)
Feat. & Disp. Ads (-2)			-0.0294	(0.025)			-0.0295	(0.0256)
TPR			-0.021	(0.0225)			-0.0175	(0.0227)
TPR(-1)			0.0078	(0.0101)			0.0075	(0.0102)
TPR(-2)			0.0366	(0.0231)			0.0325	(0.0232)
ρ	0.4179**	(0.0807)	0.3417**	(0.0893)	0.4239**	(0.0808)	0.3447**	(0.0923)
Adj. R^2	0.8671		0.8992		0.8687		0.8973	
ADF t-statistics	-11.8245**		-12.0247**		-11.5548**		-12.0639**	
Perfect reversibility, $H_0 : p_{\max} = p_{cut} = p_{rec}$					5.5356**		1.4398	
Trail et al. hypothesis, $H_0 : p_{cut} = p_{rec}$	Immediate effect				2.0338		0.3921	
	Sum of (significant) lags				2.8252*		-	

*, ** statistically different from zero at α =0.1 and 0.05, respectively.

Table 3. Estimated Results of Demand for RECON Orange Juice

	Perfectly price reversible				Imperfectly price reversible			
	Prices coupled		Prices decoupled		Prices coupled		Prices decoupled	
	Est. Coef.	Std. Err.	Est. Coef.	Std. Err.	Est. Coef.	Std. Err.	Est. Coef.	Std. Err.
Intercept	-3.3349**	(0.3074)	-3.1883**	(0.3549)	-4.4268**	(0.0284)	-4.1706**	(0.0897)
Ttrends	-0.0015**	(0.0001)	-0.0015**	(0.0002)	-0.0011	(0.0018)	-0.0050**	(0.0013)
Season1	0.0337**	(0.0063)	0.0287**	(0.0069)	0.0375**	(0.0081)	0.0337**	(0.0064)
Season2	0.0772**	(0.0065)	0.0710**	(0.0079)	0.0802**	(0.0072)	0.0841**	(0.0078)
P	-1.0932**	(0.2074)	-0.3565	(0.3448)				
P(-1)	-0.3459**	(0.0989)	-0.3158**	(0.1081)				
P(-2)	0.4015*	(0.2084)	-0.2750	(0.3500)				
P_max					2.4537	(1.4955)	-1.1538	(2.0780)
P_max(-1)					-0.6315**	(0.2500)	-0.4231**	(0.2063)
P_max(-2)					-3.7168**	(1.4958)	0.3076	(2.0861)
P_cut					-1.2964**	(0.3339)	-0.3947	(0.5430)
P_cut(-1)					-0.3172**	(0.1392)	0.0053	(0.1577)
P_cut(-2)					0.662*	(0.3870)	0.4054	(0.6096)
P_rec					-1.1017**	(0.3699)	0.6693	(0.6281)
P_rec(-1)					-0.3167*	(0.1638)	0.4304**	(0.2186)
P_rec(-2)					0.4684	(0.3081)	0.1915	(0.5661)
Feat. Ads			0.0463**	(0.0179)			0.0494**	(0.0174)
Feat. Ads(-1)			0.0384**	(0.0126)			0.0405**	(0.0121)
Feat. Ads(-2)			0.0305*	(0.0178)			0.0317*	(0.0171)
Disp. Ads			0.0294*	(0.0154)			0.0298**	(0.0144)
Disp. Ads(-1)			0.0088	(0.0080)			0.0106	(0.0071)
Disp. Ads(-2)			-0.0119	(0.0156)			-0.0087	(0.0147)
Feat. & Disp. Ads			0.0117	(0.0099)			0.0096	(0.0096)
Feat. & Disp. Ads (-1)			-0.0060	(0.0062)			-0.0062	(0.0060)
Feat. & Disp. Ads (-2)			-0.0237**	(0.0100)			-0.0219**	(0.0095)
TPR			-0.0097	(0.0162)			-0.0111	(0.0155)
TPR(-1)			-0.0129*	(0.0076)			-0.0132*	(0.0072)
TPR(-2)			-0.0160	(0.0157)			-0.0153	(0.0152)
ρ	0.2894**	(0.0802)	0.2646**	(0.0866)	0.2590**	(0.0830)	0.1710**	(0.0860)
Adj. R^2	0.8832		0.88671		0.8864		0.8932	
ADF t-statistics	-11.0154**		-11.1498**		-11.1144**		-11.2498**	
Perfect reversibility, $H_0 : p_{\max} = p_{cut} = p_{rec}$					7.6449**		11.1896**	
Trail et al. hypothesis, $H_0 : p_{cut} = p_{rec}$			Immediate effect		0.1335		1.3412	
			Sum of (significant) lags		1.6021		-	

*, ** statistically different from zero at α =0.1 and 0.05, respectively.