PRICE REACTIONS AND ORGANIC PRICE PREMIUMS FOR PRIVATE LABEL AND BRANDED MILK

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Abstract: Using Nielsen Homescan data set from 52 markets in the United States, this paper assesses the price interactions among the four fluid milk categories (organic private label, organic national brand, non-organic private label and non-organic national brand), how demographic variables and product properties in a market affect milk prices, and the impacts of private label and organic milk market shares on milk prices. We find several types of price competition exist among the four milk categories, including for example symmetric cooperative (non-organic private label vs. non-organic branded milk) and asymmetric dominant-fringe (both organic branded vs. organic private label and non-organic national brand vs. organic national brand. We also find that the organic premium for private label milk decreases with increases in the aggregate private label market share, but increases with increases in the aggregate organic market share. Alternatively, the organic price premium for national brand milk decreases with increases in both the private label share and the organic share.

JEL Codes: D43, Q13, C30

Introduction

In recent years, supermarket managers and food shoppers have witnessed the intersection of two important food trends, namely the increasing prominence of private label (PL) food products (also known as store brands), and the high-paced market growth of organic foods. Dimitri and Oberholtzer (2009) focus attention on this intersection when they report that the share of organic products sold as PLs has increased from 8 percent in 2003 to 17.4 percent in 2008. In the milk category, the focus of this research, Dimitri and Oberholtzer (2009) report that the market share for organic PL has more than doubled recently: it increased from 12 percent in 2004 to 27 percent in 2007.

Since the 1970s and 1980s, PL products have seen great improvements in product quality and large gains in market share. Of all the food products, dairy is one of the categories with highest PL expenditures and market shares. Citing Information Resources Inc., Smith (2005) claims in the trade publication *Dairy Field* that PL milk sales rose 6.8 percent during the 52 weeks ending February 20, 2005, with the dollar market share of private label milk being 58.7 percent. For the 52 weeks ending May 19, 2007, the trade publication *Progressive Grocer* reports that total private label sales across all grocery categories has reached $46.5 billion. Among all categories, private label milk leads the way with $6.5 billion (Progressive Grocer 2007).

The market for organic food is growing even faster than that for PLs. Dimitri and Oberholtzer (2009) report that U.S. retail sales of organic foods up to $21.1 billion in 2008 from $3.6 billion in 1997. Citing survey results from Hartman Group, Dimitri and Oberholtzer (2009) report that 69 percent of adults bought organic food at least occasionally in 2008, and 19 percent of consumers bought organic food weekly in 2008, up from 3 percent in the late 1990s. According to Mintel International Group's Organic Food Report in October 2008, Sung (2009) reported a 142% increase in organic food sales, growing from $2.1 billion in 2003 to an estimated $5.2 billion in 2008. Between 1999 and 2007, Sahota (2009) reports a triplingof the global organic market, which is dominated by Europe (54 percent) and North America (43 percent). In several European countries organic food sales now make up over 4 percent of total food sales (Sahota 2009).

Despite the two prominent trends briefly documented above, very little has been written about how prices are expected to react as both the organic share and PL share continue to increase. Using milk as a case study, this paper analyzes purchase data to investigate this issue. More specifically, this paper has two main objectives: (i) to model, estimate, and empirically test for price reactions of PL and branded organic and non-organic milk, and (ii) to explore, using the estimation results and simulation, how prices react to continued strong market growth. Fulfilling these two objectives will allow us to address the related question of how the observed organic price premium (for both PL and branded milk products) may change if market growth continues.

Background

A wide range of studies investigate the price premium for organic products, and/or why some consumers are willing to pay extra for it. One type is willingness-to-pay research where individuals are asked to state their preferences regarding organic produce. Relatively recent studies along these lines, which include Bougherara and Combris (2009), Batte et al. (2007), Krystallis and Chryssohoidis (2005), Loureiro and Hine (2002), Loureiro, McCluskey and Mittelhammer (2001), and Gil, Gracia and Sánchez (2000), focus on comparing organic with other ecological labels or examine differences in willingness to pay among consumer groups. Yiridoe *et al.* (2005) provide a convenient and comprehensive review of this line of study and summarize six general themes on willingness to pay for organics ranging from the effect of definitional differences to the role played by consumer knowledge and awareness.

A second type of research uses actual purchase data to study organic demand and willingness to pay for organic products. Casadesus-Masanell *et al.* (2009) use data from an outdoor clothing maker, which substituted organic cotton for conventionally grown cotton in all of its sportswear. They find that customers were willing to pay significant premiums for organic garments. Using German data on milk purchases, Jonas and Roosen (2008) find that organic milk is highly price sensitive and that previous buyers are not very loyal. Examining consumer choices of organic and conventional produce, Thompson and Kidwell (1998) find that organic food prices are significantly higher than conventional food prices, with premiums ranging from 40% to 175%.

A number of studies have investigated organic food purchases using AC Nielsen Homescan data, also used in this study, that are generated by participating households re-scanning their food purchases each week. Studying price premiums for fresh tomatoes in different regions using 2004 Homescan data, Huang and Lin (2007) show that consumers pay $0.25 more per pound in the New York-Philadelphia market, $0.14 more in the Chicago-Baltimore/Washington and the Los Angeles-San Francisco markets, and $0.29 more in the Atlanta-San Antonio market for organic tomatoes. Lin, Smith and Huang (2008) use 2005 data to estimate price premiums and discounts for five major fresh fruits and five major fresh vegetables in the United States. These price premiums vary from 20% to 42% for fruits, and vary from 15% to 60% for vegetables. Using 2006 data, Smith, Huang, and Lin (2009) find that organic price premiums for half-gallon milk range from $1.23 for whole private label organic milk (60%-68% above conventional counterpart) to $1.86 for nonfat/skim-branded organic milk (89%-109% above conventional counterpart). Finally, Alviola and Capps (2010) find that organic milk demand is more sensitive to income than its conventional counterpart.

A separate but pertinent line of research investigates strategic competition between private label and national brand food products. This research focuses on price-setting competition, and how manufacturers in one category may react to the pricing decisions by those in the other category. Examples of this research include Putsis (1997and 1999); Putsis and Dhar (1998); Mills (1999); Bontems, Monier-Dilhan, and Réquillart (1999); Coterill and Putsis (2000); Coterill, Dhar and Putsis (1999); Coterill, Putsis and Dhar (2000); Bonanno and Lopez (2005); Ward et al. (2002); Bontemps et al. (2005); Bontemps et al. (2008). Steiner (2004) reviews the history of national brand and private label competition.

Putsis (1997) provides a relevant example of this literature. He investigates price interactions and a market share effect using IRI scanner data. Results show that private label prices are positively correlated with national brand product prices, and private label market share is positively related to own price. Cotterill, Dhar and Putsis (1999) develop a framework to estimate market share and price reaction simultaneously, and find a positive relationship between shares and prices on the supply side and a negative relationship on the demand side. They also find that the branded price is higher in the markets dominated by national brands. Coterill and Putsis (2000) estimate a system of market share and price equations simultaneously, and find that positive price-following behavior between private labels and national brands is present, but not strong. They also find that markets with higher national brand market share and supermarket concentration tend to have higher prices for both national brands and private labels. Bontemps et al. (2008) study private labels, national brands and food prices using data from a consumer survey for 218 food products. They find a significant and positive relation between price of national brands and private label development. After controlling of quality effect, the relation is still positive and significant.

In the current study, we investigate the milk category because it is a product that has both a strong private label and organic presence. Milk is often used as a case study in the marketing and agricultural economics literature. Citing Information Resources Inc., Barstow (2005) claims that about 60 percent of milk is sold under a store brand. Bonnano and Lopez (2005) examine how private label market share affects prices of reduced-fat and whole milk using IRI data for 24 supermarket chains in 10 cities. The negative relationship between milk prices and private label market share, and the positive relationship between milk prices and the square of private label market share suggest a "U" shape relation between milk prices and private label market share. Milk and organic milk have also been studied as part of a demand analysis (Glaser and Thompson 2000, Tian and Cotterill 2005, and Chidmi, Lopez and Cotterill 2005).

A Model of Price Reactions

In this paper, we will investigate prices of four milk categories, namely (i) organic private label, (ii) organic national brand, (iii) non-organic private label, and (iv) non-organic national brand). We explicitly assume that prices in each aggregate category can reflect price-setting behavior by firms. In essence, therefore, the four categories of milk are treated as potential rivals. One justification for this assumption is the presence of three large firms in this sector: Horizon Organic

Organic Valley supply branded milk, and Aurora Dairy supplies organic private label milk (Dimitri and Venezia, 2007). Dimitri and Oberholtzer (2009) report that Horizon Organic's 2007 share of the organic milk market was 33 percent, Organic Valley's share was 19 percent, and the private label share was 27 percent. For our investigation, we will estimate a simultaneous equation system where endogenous prices for each of the four milk categories are modeled as being dependent on the other milk category prices as well as other non-price factors. These other factors include market shares, market demographic variables, and product attributes. Our goals, therefore, are to see if the four milk category prices do in fact react to each other, and, if they do, to use this information to investigate outcomes reflecting hypothetical market conditions.

Factors that affect the price of main milk category *i* (e.g., the price of private label organic) can be divided into five groups: (1) a vector ***D*** of consumer demographic information for specific market area , including the percentage of households with high income, average household size, average age, and ethnicity (as measured by percentage of Hispanic, African American, Asian, and White households); (2) a vector ***C*** of product attributes, including the percentage sold in large volume containers, and the percentage having containers of certain materials (carton, glass, or plastics); (3) a vector ***X*** of market structure variables, including market shares of private labels and organic milk, (4) a vector $\boldsymbol{P}^{-i}$ of prices of the other milk categories; and (5) a time variable T to capture general time trends.

The four price reaction functions include supply-side as well as demand-side variables. Because prior research shows that the price of raw milk is found to have no significant influence on milk prices (Bonnano and Lopez 2005; Chidmi, Lopez, and Cotterill 2005), and because there is no raw milk price variable available in our data set, we do not include price of raw milk in the model. However, the supply side is reflected by variables that reflect the material of milk containers. We therefore estimate four equations as following:

$$P^i = \alpha_{0i} + \boldsymbol{\alpha_{1i}P^{-i}} + \boldsymbol{\alpha_{2i}X} + \boldsymbol{\alpha_{3i}C} + \boldsymbol{\alpha_{4i}D} + \boldsymbol{\alpha_{5i}T} + \omega_i \quad \text{for i = 1, 2, 3, 4}$$

where $\alpha_{ji}, j = 0,1,2,3,4,5; and\ i = 1,2,3,4$ are vectors of coefficients, and ω_i are error terms. We can also write the four equations in the following form using variables in the estimation:

$$\begin{aligned} ORGPLPRICE = {} & \alpha_0 + \alpha_1 ORGNBPRICE + \alpha_2 NORGPLPRICE + \alpha_3 NORGNBPRICE \\ & + \alpha_4 PLSHARE + \alpha_5 ORGSHARE + \alpha_6 WEEK + \alpha_7 AVGMAXAGE \\ & + \alpha_8 AVGHHSIZE + \alpha_9 HIGHINCPER + \alpha_{10} HISPANICPER + \alpha_{11} AAPER \\ & + \alpha_{12} ASIANPER + \alpha_{13} WHITEPER + \alpha_{14} BIGVOLORGPLPER \\ & + \alpha_{15} CARTONORGPLPER + \alpha_{16} GLASSORGPLPER + \varepsilon_1 \qquad (1) \end{aligned}$$

$$ORGNBPRICE = \beta_0 + \beta_1 ORGPLPRICE + \beta_2 NORGPLPRICE + \beta_3 NORGNBPRICE + \beta_4 PLSHARE + \beta_5 ORGSHARE + \beta_6 WEEK + \beta_7 AVGMAXAGE + \beta_8 AVGHHSIZE + \beta_9 HIGHINCPER + \beta_{10} HISPANICPER + \beta_{11} AAPER + \beta_{12} ASIANPER + \beta_{13} WHITEPER + \beta_{14} BIGVOLORGNBPER + \beta_{15} CARTONORGNBPER + \beta_{16} GLASSORGNBPER + \varepsilon_2 \quad (2)$$

$$NORGPLPRICE = \gamma_0 + \gamma_1 NORGNBPRICE + \gamma_2 ORGPLPRICE + \gamma_3 ORGNBPRICE + \gamma_4 PLSHARE + \gamma_5 ORGSHARE + \gamma_6 WEEK + \gamma_7 AVGMAXAGE + \gamma_8 AVGHHSIZE + \gamma_9 HIGHINCPER + \gamma_{10} HISPANICPER + \gamma_{11} AAPER + \gamma_{12} ASIANPER + \gamma_{13} WHITEPER + \gamma_{14} BIGVOLNORGPLPER + \gamma_{15} CARTONNORGPLPER + \gamma_{16} GLASSNORGPLPER + \varepsilon_3 \quad (3)$$

$$NORGNBPRICE = \delta_0 + \delta_1 NORGPLPRICE + \delta_2 ORGPLPRICE + \delta_3 ORGNBPRICE + \delta_4 PLSHARE + \delta_5 ORGSHARE + \delta_6 WEEK + \delta_7 AVGMAXAGE + \delta_8 AVGHHSIZE + \delta_9 HIGHINCPER + \delta_{10} HISPANICPER + \delta_{11} AAPER + \delta_{12} ASIANPER + \delta_{13} WHITEPER + \delta_{14} BIGVOLNORGNBPER + \delta_{15} CARTONNORGNBPER + \delta_{16} GLASSNORGNBPER + \varepsilon_4 \quad (4)$$

Definitions and descriptive statistics for the relevant variables are in Table 1.

Coefficients α_1, β_1, γ_1, and δ_1 represent the price interaction between private labels and national brands within organic and non-organic milk. Coefficients α_2, β_3, γ_2, and δ_3 represent the price interaction between organic and non-organic for private label and national brand milk. Coefficients α_3, β_2, γ_3, and δ_2 represent the crossing categories' price interactions between organic private label and non-organic national brand milk, and between organic national brand and non-organic private label milk.[1] Each of these twelve coefficients is the direct marginal effect of $1 increase in one category on the price of another category. Using the mean values of prices, we can calculate price elasticities.

[1] By saying "crossing categories", we mean organic private label vs. non-organic national brand, organic national brand vs. non-organic private label, non-organic private label vs. organic national brand, and non-organic national brand vs. organic private label.

Table 1: Summary statistics and description of variables

	Mean	Std. Err.	Description
orgplprice	0.0455267	0.0001432	Organic private label price
orgnbprice	0.0526954	0.0001154	Organic national brand price
norgplprice	0.0242183	0.0001514	Non-organic private label price
norgnbprice	0.0385027	0.0002708	Non-organic national brand price
plshare	0.6291639	0.0040392	Private label market share
orgshare	0.3149908	0.0036999	Organic market share
week	93.91596	0.8247687	Time index
avgmaxage	6.889837	0.0093556	Average max household heads' age
avghhsize	2.58179	0.0059671	Average household size
highincper	0.3737727	0.0025533	Percentage of households with a high income
Hispanicper	0.0832654	0.0016456	Percentage of hispanic
AAper	0.0652076	0.0013117	Percentage of African American
Asianper	0.0423366	0.0009992	Percentage of Asian
Whiteper	0.8221613	0.0021526	Percentage of white
bigvolorgplper	0.0020313	0.0001943	Percentage of big volume container for organic private label milk
cartonorgplper	0.0713972	0.0013016	Percentage of carton container for organic private label milk
glassorgplper	0	0	Percentage of glass container for organic private label milk
bigvolorgnbper	0.021203	0.0007665	percentage of big volume container for organic national brand milk
cartonorgnbper	0.1511884	0.0024642	Percentage of carton container for organic national brand milk
glassorgnbper	0.0014234	0.0001219	Percentage of glass container for organic national brand milk
bigvolnorgplper	0.3975402	0.004224	Percentage of big volume container for non-organic private label milk
cartonnorgplper	0.0493456	0.0014533	Percentage of carton container for non-organic private label milk
glassnorgplper	0.0000545	0.0000267	Percentage of glass container for non-organic private label milk
bigvolnorgnbper	0.0383044	0.0015661	Percentage of big volume container for non-organic national brand milk
cartonnorgnbper	0.0605139	0.001459	Percentage of carton container for non-organic national brand milk
glassnorgnbper	0.0026618	0.0003436	Percentage of glass container for non-organic national brand milk
orgplcerealper	0.8218611	0.0426685	Organic private label cereal expenditure
orgnbcerealper	15.00919	0.2569846	Organic national brand cereal expenditure
norgplcerealper	36.94441	0.4650527	Non-organic private label cereal expenditure
norgnbcerealper	528.9248	3.937213	Non-organic national brand cereal expenditure

Putsis (1998 and 1999) divides the competitive interactions into symmetric and asymmetric patterns. Symmetric interactions, which imply a similar response to its rival, are composed of three types: Independent, cooperative, and non-cooperative interactions. Independent players do

not respond to their rivals. Cooperative players increase prices with their rivals, and non-cooperative players decrease prices when their rivals increase prices. Asymmetric interactions, which imply different responses to rivals, are composed of two types: Leader-follower (Stackelberg) and dominant-fringe. Leader-follower behavior implies that the follower reacts to changes in the leader's actions, while the leader does not. The dominant-fringe form allows two rivals to act oppositely: that is, one acts cooperatively while the other acts non-cooperatively. For example, a fringe firm may simply follow a strong rival, but the dominant one may want to protect its share by taking non-cooperative actions. Following the competition types described by Putstis (1998 and 1999), we divide the price competition into several groups according to the signs and significance of the price interaction coefficients, and present them in Table 2).

Table 2: Types of price competition and estimation coefficients

	Symmetric Interaction			**Asymmetric Interaction**	
Price Competition Categories	**Independent (Nash)**	**Cooperative**	**Noncooperative**	**Leader-Follower**	**Dominant-Fringe**
Org PL vs. Org NB	$\alpha_1 = 0, \beta_1 = 0$	$\alpha_1 > 0, \beta_1 > 0$	$\alpha_1 < 0, \beta_1 < 0$	$\alpha_1 = 0, \beta_1 \neq 0$ *or* $\alpha_1 \neq 0, \beta_1 = 0$	$\alpha_1 < 0, \beta_1 > 0$ *or* $\alpha_1 > 0, \beta_1 < 0$
Non-org PL vs. Non-org NB	$\gamma_1 = 0, \delta_1 = 0$	$\gamma_1 > 0, \delta_1 > 0$	$\gamma_1 < 0, \delta_1 < 0$	$\gamma_1 = 0, \delta_1 \neq 0$ *or* $\gamma_1 \neq 0, \delta_1 = 0$	$\gamma_1 > 0, \delta_1 < 0$ *or* $\gamma_1 < 0, \delta_1 > 0$
PL Org vs. PL Non-org	$\alpha_2 = 0, \gamma_2 = 0$	$\alpha_2 > 0, \gamma_2 > 0$	$\alpha_2 < 0, \gamma_2 < 0$	$\alpha_2 = 0, \gamma_2 \neq 0$ *or* $\alpha_2 \neq 0, \gamma_2 = 0$	$\alpha_2 > 0, \gamma_2 < 0$ *or* $\alpha_2 < 0, \gamma_2 > 0$
NB Org vs. NB Non-org	$\beta_3 = 0, \delta_3 = 0$	$\beta_3 > 0, \delta_3 > 0$	$\beta_3 < 0, \delta_3 < 0$	$\beta_3 = 0, \delta_3 \neq 0$ *or* $\beta_3 \neq 0, \delta_3 = 0$	$\beta_3 > 0, \delta_3 < 0$ *or* $\beta_3 < 0, \delta_3 > 0$
PL Org vs. NB Non-org	$\alpha_3 = 0, \delta_2 = 0$	$\alpha_3 > 0, \delta_2 > 0$	$\alpha_3 < 0, \delta_2 < 0$	$\alpha_3 = 0, \delta_2 \neq 0$ *or* $\alpha_3 \neq 0, \delta_2 = 0$	$\alpha_3 > 0, \delta_2 < 0$ *or* $\alpha_3 < 0, \delta_2 > 0$
NB Org vs. PL Non-Org PL Non-Org	$\beta_2 = 0, \gamma_3 = 0$	$\beta_2 > 0, \gamma_3 > 0$	$\beta_2 < 0, \gamma_3 < 0$	$\beta_2 = 0, \gamma_3 \neq 0$ *or* $\beta_2 \neq 0, \gamma_3 = 0$	$\beta_2 > 0, \gamma_3 < 0$ *or* $\beta_2 < 0, \gamma_3 > 0$

Two empirical issues arise when estimating the price reactions system above. First, the error terms of the four equations may be correlated because they reflect similar decisions and relay on the same data set and similar variables. Secondly, some variables are likely to be endogenous. Price variables are endogenous due to the structural system. Market shares, also, may not be orthogonal to the error terms (see for example Bontemps et al. 2005; Ward et al. 2002). A Durbin-Wu-Hausman test shows that private label milk market share (*PLSHARE*) and organic milk market share (*ORGSHARE*) are endogenous for all the equations except for the one with organic private

label milk as dependent variable.[2] Therefore, we treat market shares as endogenous variables in our model. Given these empirical issues, we estimate our empirical model with three-stage least squares (3SLS), which provides consistent estimation and allows for correlation among error terms.[3] In addition to other exogenous variables included in (1) to (4), expenditures on various categories of ready-to-eat cereals are included as instrumental variables in the four price reaction equations. We use cereal expenditures because it is usually purchased or consumed with milk in a somewhat complementary fashion. We calculated ready-to-eat cereal expenditures on four categories (organic private label, organic national brand, non-organic private label, and non-organic national brand) for each market in each week, and use these expenditures as instrumental variables. Therefore, in this paper, a four-equation 3SLS model is estimated to investigate milk prices, and reactions for four milk categories (organic and non-organic private label, organic and non-organic national brand).

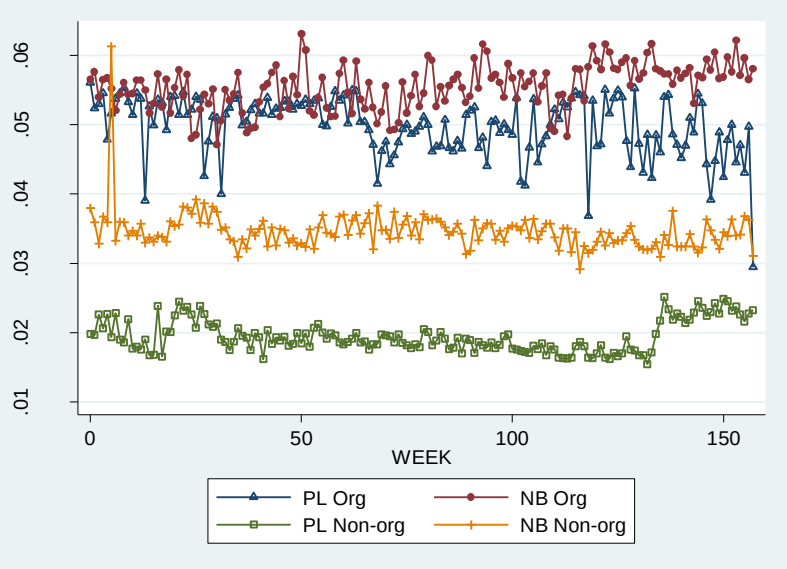
Data

The data used in this study are Nielsen Homescan data on food products across 52 geographic markets from 2004 to 2006. The Homescan have previously been used to study marketing activities and consumer purchase behavior in agribusiness and agricultural economics literatures (see for example Smith, Huang, and Lin 2009, and Arnade, Gopinath, and Pick 2008). The 52 markets, taken directly from Nielsen, represent major and mid-sized markets in the United States. To collect prices for each of the four milk categories, we aggregate the original household-level data on milk purchases to the market level to obtain an average weekly price in each of the 52 markets. This aggregation process results in 8,104 observations in the data set. Figure 1 shows the weekly prices for organic private label, organic national brand, non-organic private label, and non-organic national brand milk in market 12 (San Francisco) from 2004 to 2006. Price trends of other markets are similar.

[2] We tested the endogeneity of market shares by including the residuals of private label market share and organic market share in the regression system. The coefficients of market share residuals are all significant except for the equation with organic private label price as dependent variable. This non-significant result may due to the low market share of organic private label milk.

[3] For more details about 3SLS, please see Greene (2003).

Figure 1: 2004 to 2006 Weekly Prices for Four Categories of Milk, Market 12



Other variables in the model include market shares, demographics, and percentage of various product properties. Expenditures on the out-of-category product ready-to-eat cereals are included as instrumental variables. Table 1 provides a brief description and statistical summary of all the variables.

Results

Table 3 presents the results of the four price equations (1) – (4) estimated via 3SLS. The results and interpretation of specific factors are discussed in turn**.** For non-organic milk, we find that the private label price and the branded price are positively related. This result is generally consistent with other research (Putsis 1997; Bontemps et al. 2008).[4] Following Table 2, we conclude that non-organic private label and non-organic national brand products have a symmetric cooperative price reaction. The non-organic private label price has a first-level cross-price elasticity of 0.27 with respect to non-organic branded price.[5] Conversely, the non-organic national brand price has an elasticity of 0.13 with respect to the non-organic private label price.

[4] These studies investigate the price reaction between private labels and national brands. Since non-organic products dominate organic products for most product categories, we believe the results are similar to those of non-organic products.

[5] Here, we begin to use the term "first-level" cross products to refer to attribute differences in the private label-brand dimension, but not the organic attribute dimension. We use the term second-level cross products to refer to product attribute differences in both the organic attribute and the branding dimension.

Table 3: 3SLS results for four milk categories

	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.
orgplprice			orgnbprice			norgplprice			norgnbprice		
orgnbprice	0.2944592***	0.0919	orgplprice	-0.271264***	0.0586	orgplprice	-0.0482048	0.0551	orgplprice	0.2092923	0.1282
norgplprice	-0.06326*	0.0373	norgplprice	-0.040852	0.0313	orgnbprice	-0.359517***	0.0772	orgnbprice	-0.6057241***	0.1740
norgnbprice	0.1018668**	0.0411	norgnbprice	0.1305724***	0.0331	norgnbprice	0.1669019***	0.0307	norgplprice	0.2029762***	0.0670
plshare	-0.0009981	0.0020	plshare	-0.0034466**	0.0015	plshare	0.0095621***	0.0014	plshare	0.0117516***	0.0038
orgshare	-0.0012834	0.0028	orgshare	-0.0036946**	0.0016	orgshare	-0.0103321***	0.0016	orgshare	0.0104255***	0.0039
week	0.0000184***	0.0000	week	0.0000674***	0.0000	week	0.0000412***	0.0000	week	-0.000021*	0.0000
avgmaxage	0.00000243	0.0004	avgmaxage	-0.0000509	0.0003	avgmaxage	-0.0018586***	0.0003	avgmaxage	0.0019735***	0.0007
avghhsize	0.0017082***	0.0006	avghhsize	-0.0002389	0.0005	avghhsize	-0.0019358***	0.0004	avghhsize	0.0009949	0.0011
highincper	0.001719	0.0014	highincper	0.0067523***	0.0010	highincper	0.0021708**	0.0011	highincper	0.0067808***	0.0026
Hispanicper	0.0030892	0.0030	Hispanicper	-0.0017267	0.0023	Hispanicper	0.0054972**	0.0024	Hispanicper	-0.0125496**	0.0056
AAper	0.0134241***	0.0041	AAper	0.0086965***	0.0032	AAper	0.0236963***	0.0032	AAper	-0.006297	0.0078
Asianper	0.0304655***	0.0051	Asianper	0.0161547***	0.0042	Asianper	-0.0133759***	0.0042	Asianper	-0.0369346***	0.0099
Whiteper	0.009274***	0.0035	Whiteper	0.0000891	0.0027	Whiteper	0.0039648	0.0028	Whiteper	-0.0182915***	0.0065
bigvolorgplper	-0.1271176***	0.0150	bigvolorgnbper	-0.0454457***	0.0042	bigvolnorgplper	-0.0298981***	0.0013	bigvolnorgnbper	-0.042445***	0.0052
cartonorgplper	0.0043783	0.0037	cartonorgnbper	-0.0065754***	0.0021	cartonnorgplper	0.0148174***	0.0020	cartonnorgnbper	0.0150419***	0.0052
glassorgplper	(dropped)		glassorgnbper	0.1341249***	0.0202	glassnorgplper	0.020627	0.0717	glassnorgnbper	0.0315934**	0.0143
_cons	0.0117572*	0.0069	_cons	0.0570387***	0.0043	_cons	0.0557475***	0.0054	_cons	0.0472648***	0.0138

Note: *** means significant at 1%, ** means significant at 5%, and * means significant at 10%.
Coefficient for "glassorgplper" is dropped in the 2nd column because it equals 0 for each market in each week.

On the contrary, for organic milk, the national brand price and private label price react to each other in decidedly different fashions. The price of organic private label milk has a first-level cross elasticity of 0.34 with respect to the organic national brand milk price, while the organic national brand price elasticity is – 0.23 with respect to the organic private label price. This type of price reaction falls into the category of asymmetric dominant-fringe price competition. This outcome fits the reality that the organic national brand dominates organic milk in market share.

For private label milk, the organic private label price decreases with the increase of non-organic private label price, and vice versa. However, neither of the reactions is significant at 5% level, and the magnitude is relatively low (both below $0.007 in absolute dollar value and 0.09 percent in elasticity). This result suggests that private label organic milk and private label non-organic milk set their pricec independently.

For national brand milk, we see an asymmetric dominant-fringe price relationship between non-organic and organic brands. The elasticity of the organic branded milk price with respect to the non-organic branded milk price is 0.08, whereas the elasticity of the non-organic branded milk price with respect to the organic branded price is –0.829. The asymmetric dominant-fringe relationship is consistent with the Homescan data, where the non-organic national brand is dominant in market share relative to the organic brand.[6]

For second-level cross categories, the organic and non-organic private label milk prices react to cross categories significantly, while organic and non-organic national brand milk reacts to cross categories non-significantly. To be specific, the elasticity of the organic private label price with respect to the non-organic branded price is 0.08. On the other hand, the price of the non-organic national brand does not react significantly to the organic private label price. The elasticity of the non-organic private label price with respect to the organic branded price is – 0.78. Again, the organic national brand price does not react to non-organic private label price significantly. These responses suggest a leader-follower type of asymmetric price competition. The non-organic national brand is the leader in the competition with organic private label milk, and organic national brand is the leader in the competition with non-organic private label milk. Table 4 summarized the price competition types among the four milk categories.

[6] Using Nielsen Homescan data from 2004 to 2006, we find that non-organic national brand milk doubles the market share of organic national brand milk (21.4% vs. 11.2%).

Table 4: Four category competition types

Price Competition Categories	Price Competition Types
Organic PL vs. Organic NB	Asymmetric Dominant (Organic NB)-Fringe (Organic PL)
Non-org PL vs. Non-org NB	Symmetric Cooperative
PL Organic vs. PL Non-org	Symmetric Independent
NB Organic vs. NB Non-org	Asymmetric Dominant (NB Non-org)-Fringe (NB organic)
Organic PL vs. Non-org NB	Asymmetric Leader (Non-org NB)-follower (Organic PL)
Non-org PL vs. Organic NB	Asymmetric Leader (Organic NB)-follower (Non-org PL)

Market Shares

The results in Table 3 also shows the affect that the aggregate market shares have on prices. The private label market share (both organic and non-organic) and the organic market share (both private label and branded) affect three of the milk prices significantly; the organic private label milk price is the exception. A higher market share for the aggregate private label (i.e., both organic and non-organic private label) category leads to a lower organic national brand price, but higher non-organic private label and national brand prices. A higher market share for the aggregte organic category (i.e., both organic private label and organic branded products) leads to a higher non-organic national brand price, but lower organic national brand and non-organic private label prices. We can see from Table 3 that the magnitude of organic share coefficient is always similar to or higher than private label share coefficient.

Demographics and Products Attributes

Table 3 also shows the effect of market-level demographic variables on milk categories' prices. We summarize seven demographic results: 1) A higher average age of household heads is related to a lower non-organic private label milk price and higher non-organic national brand milk price. It does not affect two organic milk categories significantly. 2) Larger average household size in a market is related to a higher organic private label price and a lower non-organic private label price. It does not affect two national brand milk categories. 3) A higher percentage of high income households in a market relates to higher prices, as expected, for all the four milk categories.[7] 4) A

7 The Homescan data contains 16 category codes for particular income ranges. Households in the second highest income category ranges from $70,000 to $99,999, and the top income category containing households with more than $100,000 a year in income. We define high income as the households with annual income in the highest two categories.

higher percentage of Hispanic households relates to a higher non-organic private label price and a lower non-organic national brand price. It does not affect two organic milk categories significantly. 5) The percentage of African Americans does not affect the non-organic national brand milk price significantly, but it affects all the other three milk categories positively and significantly. 6) A higher percentage of Asian households in a market relates to lower prices of non-organic milk categories and higher prices of organic milk categories. 7) The percentage of white households relates to a higher price of organic private label milk and a lower price of non-organic national brand milk, but it does not affect the other two categories significantly.

In each of the four milk categories, product attributes such as big volume containers, carton packaging and glass packaging are calculated as percentage of products in the market. Here, three results emerge: 1) A higher percentage of own category big volume packaging is always related to lower milk prices as expected. 2) Own category carton container percentages is related to higher milk prices except for organic national brand milk. 3) Glass container percentage is zero in all the weeks for organic private label milk, so the coefficient is dropped for this category. It has a positive relationship with category prices otherwise, with the effect on non-organic private label milk prices non-significant.

Organic Price Premiums

Using the Table 3 results, we simulate prices based on new scenarios for aggregate market shares of private label milk and organic milk. These scenarios represent 10 and 20 percent increases (i.e., level increases) to the current market shares for all private label milk (i.e., both organic and non-organic private label milk) and all organic milk (i.e., both organic private label and organic branded milk), reported as 62.9 percent and 31.5 percent, respectively, for the 52 Homescan markets from 2004 to 2006.[8] Table 5 first reports the current organic-to-non-organic price ratio for private label milk (1.8798) and national brand milk (1.3686) found in our data. These ratios represent organic price premiums of 88 percent and 37 percent, respectively, for private label and branded milk. Table 5 next reports the simulation results and shows how organic price premiums change with simulated changes to the market shares for private label milk and/or organic milk. An increase in the organic market share alone, without a corresponding increase in the private label

[8] Note that organic market share of 31 percent is higher than other reports because the data are limited only to the 52 major and midsized markets. Note also that it reflects a dollar share and not a volume share.

market share, raises the organic price premium for private label milk but decreases the organic price premium for national brand milk. A 20 percent increase in the organic market share leads to new organic price premiums of 104 percent for private label milk and 28 percent for branded milk. However, an increase in the private label market share alone, without a corresponding increase in the organic market share, decreases organic price premiums for both private label and branded milk. Here, a 20 percent increase in the private label market share leads to new organic price premiums of 73 percent for private label milk and 27 percent for branded milk. When both the organic and private label shares increase by 20 percent, the organic price premium is nearly unchanged (at 87 percent) for private label milk, but the drops considerably (to 19 percent) for branded milk.

Table 5: Simulated organic price premium changes due to market share changes

Market Share	Relative Price: PL-O/PL-Non	Relative Price: NB-O/NB-Non
Current Shares	1.880	1.3686
PL Share + 10%	1.804	1.319
Organic Share+10%	1.958	1.323
PL & Organic Share + 10%	1.876	1.277
PL Share + 20%	1.735	1.273
Organic Share+20%	2.044	1.280
PL & Organic Share + 20%	1.873	1.194

Conclusion and Discussion

Using Nielsen Homescan data set from 52 markets in the United States, this paper assesses the price interactions among the four fluid milk categories (organic private label, organic national brand, non-organic private label and non-organic national brand), how demographic variables and product properties in a market affect milk prices, and the impacts of private label and organic milk market shares on milk prices. Results from empirical analysis show that 1) private label organic premium decreases with private label market share but increase with organic market share, while national brand organic price premium decreases with both private label share and organic share; 2)

Types of price competition among the four milk categories include symmetric cooperative (non-organic PL vs. non-organic NB), symmetric independent (organic PL vs. non-organic PL), asymmetric dominant-fringe (organic NB vs. organic PL and non-organic NB vs. organic NB), and asymmetric leader-follower (non-organic NB vs. organic PL and organic NB vs. non-organic PL). This paper is among the first to analyze private label and organic prices simultaneously in a strategic fashion. Results from this paper will give food manufacturers, retailers, and food researchers insights on how to make effective price strategies, how to react to expansion of private label and organic products, and how to target a new market.

Organic milk producers and processors may be keenly interested in the implications our results have on organic price premiums. As the market supply and demand for organic milk continues to increase, organic industry participants worry that market growth may depress price premiums. Our results show that a lower price premium may in fact be the case for branded milk. However, for private label milk, the dual trends of organic and private label growth can have a somewhat moderating effect: we find that the price premium for organic private label milk is nearly unchanged if organic and private label milk grow at similar rates. This result might be perceived as good news by organic milk producers and processors.

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