Energy Price Transmission and Retail Milk Prices

Xun Li and Rigoberto A. Lopez*

Selected paper presented at

The Agricultural and Applied Economics Association Meetings

July 26 – 28, 2015, San Francisco, California

*The authors are, respectively, assistant professor in the School of Economics and Management at Wuhan University in China and professor and in the Department of Agricultural and Resource Economics at the University of Connecticut, Storrs, CT, 06268. Contact: rigoberto.lopez@uconn.edu. Funding from the Zwick Center for Food and Resource Policy is gratefully acknowledged.

Energy Price Transmission and Retail Milk Prices

Xun Li and Rigoberto A. Lopez

Abstract

This paper estimates the pass-through between diesel fuel and retail milk prices at the product brand level, based on a random coefficient logit demand model along with a market channel marginal cost function in order to estimate energy price pass-through rates to the consumer. It takes into account the partial and net impact of energy prices through the multi-market effects on other inputs. It also exploits a natural experiment of energy hyperinflation and the great recession in 2008. Empirical results show that energy prices (e.g., diesel price) significantly impact the retail prices of milk products and are, therefore, an important determinant of food price inflation. Pass-through rates are estimated to be in the range from 0.15 to approximately 0.50 before March 2008 and from 0.09 to 0.19 after March 2009, with an average of 0.26. This indicates that a $1.00 per gallon increase in diesel prices would on average result in a 26¢ per gallon increase in the retail price of milk. Statistical test indicates pass-through rates before March 2008 are significantly higher than that after March 2008. Interestingly, private label brands have the lowest energy (diesel) pass-through rates, implying that compared to manufacturer brands, private label prices are more insulated from energy price shocks.

Keywords: food, milk, energy, pricing, pass-through

JEL: D22, L66, Q13, Q41

Introduction

In the last few years, U.S. food and energy prices have both experienced dramatic increases, resulting in a dual food and energy price inflation that has had a significant negative impact on consumers. Much of the previous literature sheds light on the relation between oil prices and agricultural commodity or food prices. Generally speaking, the causal link between oil and food prices is explained by two mechanisms (Reboredo, 2012). First, oil prices affect production costs directly, given that agriculture is an energy-intensive sector. For example, Hanson, Robinson and Schluter (1993) and Nazlioglu (2011) find that an increase in oil prices causes a rise in input costs and a corresponding rise in agricultural commodity prices. The strength of this effect depends on several factors, such as the relative importance of oil in the production costs and the degree of market power to pass forward increased costs. Second, on the demand side, increased oil prices have significantly raised demand for corn- and soybean-based biofuels resulting in an indirect increase in the prices of these commodities due to increased demand. Chen, Kuo and Chen (2010) and Ignaciuk and Dellink (2006) show that higher crude oil prices have induced a higher derived demand for corn and soybeans and greater competition with other grains for the planting areas, resulting in increased grain prices for wheat as well as corn and soybeans. Higher grain prices increase the cost of feed used in animal agriculture such as milk production.

Yet some studies have found no statistically significant evidence regarding an oil-food price nexus. For example, Zhang et al. (2010) find that agricultural commodity prices are neutral to oil price changes in the long run. Gilbert (2010) explains the recent upward trend in agricultural prices by distinguishing between common and market-specific factors, reporting evidence of the neutrality of market factors like oil prices and biofuel demand.

The preponderant evidence in previous studies links oil and agricultural commodity price indexes at the aggregate farm level. However, previous studies linking food and energy prices at the retail product brand level are lacking, although this is the level more relevant to consumers. Retail milk provides a good case study for examining the relation between energy and retail food prices. First, energy plays an important role in milk production as well as transportation and marketing (Brush, Masanet and Worrell, 2011). Second, given the prevalence of obesity and over-consumption of sugar-sweetened beverages (SSBs), milk is considered a lower-calorie and more nutritious substitute for SSBs (Runge, Johnson and Runge, 2011). Third, the price of milk as a staple food is closely connected with consumers' welfare and social well-being, particularly children's.

Using a random coefficient logit model at the product brand level, this paper estimates the retail demand for fluid milk in Boston and related energy pass-through rates before March 2008 and after March 2008. Empirical results indicate that, overall, consumers prefer milk products with lower prices and larger sizes and favor private labels, resulting in lower price elasticities and higher oligopoly Lerner indexes. Finally, energy prices (i.e., diesel and electricity) significantly impact the cost of milk products. The pass-through rate for diesel averages approximately 0.26 across brands and time periods, with a range from 0.15 to 0.50 before March 2008 and 0.09 to 0.19 after March 2008. Statistical test indicates pre-period pass-through rates are significantly higher than that of post-period In general, private labels have lower energy (diesel) pass-through rates, indicating less vulnerability to energy price shocks and more stable prices.

Empirical Strategy

Cost pass-through rates measure the proportion of a change in input costs that is transmitted to the output price. In this paper, a structural model is applied with consideration of firms' competitive interaction, [1] using a random coefficient logit demand model to capture product and consumer heterogeneity. The supply side (i.e., margins or marginal costs) is derived in a post-demand estimation stage.

The indirect utility of consumer i from purchasing milk brand j in market m is given by

$$u_{ijm} = \delta_{jm} + \mu_{ijm} + \epsilon_{ijm}, \tag{1}$$

where the indirect utility u_{ijm} can be decomposed into three parts: a mean utility term δ_{jm}, which is common to all consumers; a brand-specific and consumer-specific deviation from that mean μ_{ijm}; and idiosyncratic tastes ϵ_{ijm}, where ϵ_{ijm} is a mean zero stochastic term distributed independently and identically as a type I extreme value distribution. The mean utility $\delta_{jm} = X_j' \beta + \xi_{jm}$ includes a vector X_j of key product characteristics of relevance to consumers; ξ_{jm} is unobserved product characteristics. The utility deviations are $\mu_{ijm} = X_j' \Sigma V_i$, where Σ is a scaling matrix and random part V_i is assumed to have a standard multivariate normal distribution. Then the probability that consumer i purchases a unit of brand j in market m is given by

$$s_{ijm} = \frac{exp(\delta_{jm}+\mu_{ijm})}{1+\sum_{r=1}^{J} exp(\delta_{rm}+\mu_{irm})}. \tag{2}$$

The market share of the j^{th} brand corresponds to the probability that the j^{th} brand is chosen in market m, given by

$$s_{jm}(p, x, \theta) = \int I\{(v_i, \epsilon_{ijm}): U_{ijm} \geq U_{ikm} \; \forall k = 0, \dots, J\} dG(v) dF(\epsilon),$$

(3)

where θ is a vector of consumer taste parameters; $k=0$ denotes the outside good; and G and F are cumulative density functions for v and ϵ, respectively, assumed to be independent of each other.

[1] A reduced-form analysis is simple, but disadvantageous for inferring the degree of market competitiveness without knowing the benchmark pass-through rate (Kim and Cotterill, 2008).

The price elasticities of brand j in market m can be expressed as:

$$\eta_{jm} = \frac{\partial s_{jm}}{\partial p_{km}} \cdot \frac{p_{km}}{s_{jm}} = \begin{cases} \frac{p_{jm}}{s_{jm} \int \alpha_i s_{ijm}(1-s_{ijm}) dG(v)}, \ for\ j = k, \\ \frac{-p_{km}}{s_{jm} \int \alpha_i s_{ijm} s_{ikm} d(v)}, \ otherwise, \end{cases} \tag{4}$$

where α_i denotes the price coefficient of individual i.

Since the pass-through rate depends on the demand and cost structures, a suitable model of a firm's behavior is of great importance for properly estimating a pass-through rate. We follow Berry, Levinsohn and Pakes (1995) (hereafter BLP), and Nevo (2001) who assume that firms follow a Bertrand-Nash pricing strategy. Assume that constant marginal costs vary across markets. Firm f's profit in market m is then given by

$$\pi_f^m = \sum_{j \in J_f} (p_{jm} - mc_{jm}) M s_{jm}(p) \quad ,$$

(5)

where mc_{jm} is the marginal cost of brand j in market m, J_f is the set of brands produced by firm f, M is market size, and $s_{jm}(p)$ is the market share of brand j in market m. The first order condition for profit maximization is:

$$\frac{\partial \pi_f^m}{\partial p_{km}} = M \left[s_{jm}(p) + \sum_{j \in J_f} (p_{jm} - mc_{jm}) \frac{\partial s_{jm}}{\partial p_{km}} \right] = 0.$$

(6)

In vector notation, the pricing equation can be written as

$$p - mc = \left[\Theta^{own} * \left(-\frac{\partial s(p)}{\partial p} \right) \right]^{-1} s(p \quad),$$

(7)

where

$$\Theta_{i,j}^{own} = \begin{cases} 1, \text{if } i, j \text{ are produced by same firm,} \\ 0, \text{otherwise,} \end{cases}$$

Following Chidmi, Lopez and Cotterill (2005) as well as Richards, Allender and Hamilton (2012), the marginal cost is assumed as a function of the raw milk price P_f, the diesel price P_d, the electricity price P_e, package size S, fat content F, and time dummies (year and month) D. The most common form for the marginal cost function in the previous literature is the log-linear form used by Berry et al. (1995) and Sudhir (2001). A log-linear version of (3.2.8) results in the following empirical equation:

$$lnmc = \alpha_0 + \alpha_1 lnP_f + \alpha_2 lnP_d + \alpha_3 lnP_e + \alpha_4 lnS + \alpha_5 lnF + \alpha_6 lnD + \varepsilon_1, \tag{8}$$

where $\varepsilon_1 \sim N(0, \sigma_{\varepsilon_1}^2)$ are the unobservable factors.

As energy prices are also likely to affect input costs such as raw milk, the indirect effects of energy prices have to be taken into account in the marginal cost function. To this end, the raw milk price is simply modeled as a function of feed prices (P_{fd}) as well as energy prices, and is assumed to be given by

$$lnP_f = \beta_0 + \beta_1 lnP_{fd} + \beta_2 lnP_d + \beta_3 lnP_e + \beta_4 lnD + \varepsilon_2, \quad (9)$$

where ε_2 are the unobservable factors that affect the raw milk price and $\varepsilon_2 \sim N(0, \sigma^2_{\varepsilon_2})$. The total change in marginal cost from a change in the price of diesel is given by the sum of direct effect through (8) and the indirect effect through changes in (9). Substituting equation (9) into equation (8) yields

$$lnmc = \lambda_0 + \lambda_1 lnP_{fd} + \lambda_2 lnP_d + \lambda_3 lnP_e + \alpha_4 lnS + \alpha_5 lnF + \lambda_4 lnD + v \quad ,$$

(10)

where $\lambda_0 = \alpha_1\beta_0 + \alpha_0$; $\lambda_1 = \alpha_1\beta_1$; $\lambda_2 = \alpha_1\beta_2 + \alpha_2$; $\lambda_3 = \alpha_1\beta_3 + \alpha_3$; $\lambda_4 = \alpha_1\beta_4 + \alpha_6$; and $v = \varepsilon_1 + \alpha_1\varepsilon_2$. ε_1 and ε_2 are random shocks, which are assumed independent from each other, and $v \sim N(0, \sigma^2_{\varepsilon_1} + a_1^2\sigma^2_{\varepsilon_2})$.

Using (7) and (10), a diesel price shock from $\overline{P_d}$ to $\widehat{P_d}$ will induce a new set of equilibrium milk prices, depicted by $\hat{P}$. The total diesel price pass-through rate (Γ) is then defined as the ratio of the milk price change to a change in diesel price, given by

$$\Gamma = \frac{\Delta p}{\Delta P_d} \times 100 \quad ,$$

(11)

where Δp denotes differences between the new equilibrium prices and the old ones, and the change in diesel prices is given by $\Delta P_d = \widehat{P_d} - \overline{P_d}$.

Data and Estimation

The main dataset used, milk sales data, came from the Information Resources Incorporated (IRI) Academic Data database, available online to academic researchers.[2] The milk data set contains brand-level information in the greater Boston area aggregated to four-week periods from January 2009 through December 2011. As shown in Table 1, product characteristics include brand name,[3] fat content (0, 1%, 2% and 3.25%), lactose content (free or not) and package size. Following Lopez and Lopez (2009), all milk types with less than 0.1% share of the IRI sample were dropped, which generated 60 products defined by these four product characteristics.

Retail prices of milk were computed by dividing the dollar sales by volume sold. Market shares for each product were computed with respect to the potential market for milk, which was calculated by multiplying the total population of the Boston area by the average U.S. per capita milk consumption (USDA, 2012). The outside good is defined as the part of the potential market that is not considered in the sample, i.e., the total amount of fluid milk sold in the Boston area that is either not part of the 60 milk

---

[2] See Bronnenberg, Kruger and Mela (2008).

[3] Garelick Farms, Garelick Farms over the Moon, Hood, Hood Lactaid, Hood Simply Smart, Private Labels, Stonyfield Farm, and the Organic Cow of Vermont. Private Labels (store brands) were aggregated as a single brand. These are shown in Table 1.

products in the sample or that is sold in other retail outlets.[4] As a result, the volume of milk included in the dataset used in this study represents approximately 65% of the potential market. Each time period was treated as a market consisting of 60 products and 200 consumers, which generated 4320 markets (60 products x 72 months = 4,320) and 864,000 (4320 x200) consumer observations. In this research, the sample is segmented according to pre-March 2008 and post-March 2008, including 27 markets and 45 markets, respectively.

Monthly averages of retail diesel prices were collected from the Mid-Atlantic Information Office of the Bureau of Labor Statistics (BLS, 2013), from 2006 through 2011 to match milk sales. Electricity prices were collected from the U.S Energy Information Administration (EIA, 2006-2011).

Instrumental variables are used to address potential endogeneity of milk prices, chosen so that demand shocks ϵ are independent of a set of exogenous instruments ω (i.e., $E[\epsilon|\omega] = 0$) but correlated with prices. Following BLP (1999) and Nevo (2001), the instrumental variables used include cost shifters (diesel price, electricity rate, wage rate, interest rate), the average price in other markets (Hausman and Taylor, 1981) and brand and month dummies as well as non-price product characteristics. The demand model specified can be estimated with the complete set of instrumental variables, including cost shifters, Hausman-type instruments, using a non-linear Generalized Methods of Moments (GMM) estimator. Following Dubé et al. (2012), we apply a mathematical program with equilibrium constraints (MPEC).

The estimated demand parameters are used to calculate product-specific price elasticities and the retailer price-cost margins. Based on the estimates, the pass-through rate is calculated by simulation. All the results are presented in the following section.

Results

Table 2 presents the estimation results of demand function. Overall, the results seem plausible in terms of signs and expected coefficients. On average, consumers have a negative and strong valuation of price and size in the two time periods. Compared with other brands, consumers prefer private labels, which is consistent with the finding of Lopez and Lopez (2009). Table 2 also shows consumers' significant heterogeneous preference for milk product characteristics such as price, which confirms heterogeneity in consumers' preferences in the Boston fluid milk market.

Table 3 illustrates that all the own-price elasticities of demand are negative and all cross-price elasticities are positive for the milk products before March 2008 and after March 2008. For the private labels, the own-price elasticities are comparatively lower than those of other brands, which indicate that private labels are exerting more market power. Totally speaking, the values of the estimated own-price

[4] The sample includes sales at grocery stores and drugstores. Among other things, all outlets include milk purchased at superstores, restaurants, gas stations, and convenience stores.

elasticities range from -7.961 to -25.415 during 2006-2011. These estimates of elasticities are within the range of conclusions given in previous studies focusing on fluid milk. For instance, Cotterill and Dhar (2003) provide own-price elasticities estimates as high as -35 for Hood milk and -3.62 for private label milk, while Lopez and Lopez (2009) find that the elasticities for milk in Boston range from -1.98 for 1% low fat private label milk to -8.52 for 1% lactose free Morningstar milk. Kinoshita, Suzuki, and Kaiser (2002), with scanner brand-level data in Japan, find price elasticities in the range of -6.67 to -9.19. It is not surprising that the elasticities estimates in this research are relatively higher compared to those brand-level studies. A possible explanation is that this paper focuses on product level, which is smaller and defined by specific product characteristics, as opposed to brand level. In this research consumers have more substitutes to switch to, resulting higher price elasticities.

Table 4 and Table 5 both show that private label milk has the highest Lerner Index, i.e., the highest percent markup. This result is consistent with the finding of Lopez and Lopez (2009). One explanation is that although the prices of private labels are relatively lower than those of other products, the marginal costs are also lower so that markups are higher. Comparison between Lerner Indexes pre-March 2008 and post-March 2008 indicate that markets powers of most of these popular brands/products significantly increase.

Table 6 reports the estimation results for marginal cost function for pre-period sample and post-period sample. With the pre-period sample, estimation results show that a 1% diesel price increase will lead to a 0.363% increase in marginal cost, while a 1% feed price increase leads to a 0.135% increase in marginal cost. The results also show that a 1% package size leads to a 0.439% decrease in marginal cost as the cost of an additional gallon of milk decreases if produced and marketed in a bigger container. Similarly, in the post-period, results show that 1% diesel price increase will lead to a 0.147% increase in marginal cost, and a 1% electricity price increase leads to a 0.673% increase in marginal cost.

Table 7 illustrates the estimated energy (diesel) pass-through rate for 60 products in pre-period and post-period. Overall, the pass-through rates during 2006-2011 range from 0.089 to 0.506, with a mean of 0.26, which indicates that, on average, a dollar per gallon increase in diesel price will lead to a 26 cents per gallon increase in retail milk price. In addition, the results show that the pass-through rates of private label products, generally speaking, are lower than those of other brands. These findings indicate that the private labels are less vulnerable to energy price shocks compared to manufacturer brands. One possible reason is the higher price-cost markups of private labels. When energy price shocks increase marginal cost, it is still profitable for private labels to increase price by a smaller amount when compared to manufacturer brands. The estimated pass-through rates in two periods are compared in term of means with two-sample t test. With t-stat value of 14.06, the pass-through rates are statistically higher pre-March 2008, implying that the pass-through might be asymmetric.

Conclusions

This paper investigates the demand for a differentiated product market (Boston fluid milk) and estimates pass-through rates for energy price shocks pre- and post-March 2008. The demand is estimated with a random coefficient logit model, which allows for a more flexible curvature of demand, hence flexible pass-through rates that are not driven solely by the functional form assumption.

Empirical results indicate that fluid milk products with lower prices and smaller sizes are more popular. Empirical results also show that the private labels have lower price elasticities as well as the highest degrees of market power. This finding lends support to previous studies that have similarly found that more basic products (in this case, private label milk) benefit from greater price-cost margins (Chidmi and Lopez, 2009). In addition, this research also finds that energy prices (e.g., diesel and electricity) significantly impact the prices of milk products. The pass-through rates average 0.26. Interestingly, most private labels are found to have the lowest energy (diesel) pass-through rates, which is consistent with the relatively stable price of private label products. This finding also implies that compared to manufacturer brands, private labels are less vulnerable to energy price shocks. Taking into account the lower prices of private label retail milk, greater price stability amount to added benefits to consumers from private label milk consumption. Besides, pass-through rates pre-March 2008 are statistically significantly higher compared to that of post-March 2008, via a two-sample t test, implying the existence of asymmetric energy pass-though.

References

Berry, S., J. Levinsohn, and A. Pakes, 1995. Automobile Prices in Market Equilibrium. *Econometrica,* 63, 841-890.

Berry, S., J. Levinsohn, and A. Pakes, 1999. Voluntary Export Restraints on Automobiles: Evaluating a Trade Policy. *The American Economic Review*, Vol. 89(3), 400-30.

Bronnenberg, B.J., M.W. Kruger, and C.F. Mela, 2008. Database paper: The IRI marketing data set. *Marketing Science*, 27(4) 745-748.

Brush, A., E. Masanet, and E. Worrell, 2011. Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry: An ENERGY STAR Guide for Energy and Plant Managers. eaei.lbl.gov/sites/all/files/lbnl-5303e.pdf. Accessed April 10, 2014.

Chen, S., H. Kuo, and C. Chen, 2010. Modeling the Relationship between the Oil Price and Global Food Prices. *Applied Energy*, 87, 2517-2525.

Chidmi, B., and R. A. Lopez, 2007. Supermarket-Brand Level Demand for Breakfast Cereals and Retail Competition. *American Journal of Agricultural Economics* 89 (2): 324-337.

Chidmi, B., R.A. Lopez, and R.W. Cotterill, 2005. Retail Oligopoly Power, Dairy Compact, and Boston Milk Prices. *Agribusiness* 477-491.

Cotterill, R.W. and T. Dhar, 2003. Oligopoly Pricing with Differentiated Products: The Boston Fluid Milk Market Channel. Research Report Series. University of Connecticut, Storrs, CT.

Dubé J-P, J.T. Fox, and C-L. Su, 2012. Improving the Numerical Performance of Static and Dynamic Aggregate Discrete Choice Random Coefficients Demand Estimation. *Econometrica*, 80(5):2231–2267.

Gilbert, C.L., 2010. How to Understand High Food Prices. *Journal of Agricultural Economics*, 61, 398-425.

Hanson, K., S. Robinson and G. Schluter, 1993. Sectoral Effects of a World Oil Price Shock: Economywide Linkages to the Agricultural Sector. *Journal of Agricultural and Resource Economics*, 18(1), 96-116.

Hausman, J.A. and W.E. Taylor, 1981. Panel Data and Unobservable Individual Effects. *Econometrica*, 49, 1377–1398.

Ignaciuk, A.M. and R.B. Dellink, 2006. Biomass and Multi-product Crops for Agricultural and Energy Production- An AGE Analysis. *Energy Economics* 28, 308-325.

Kim, D. and R.W. Cotterill, 2008. Cost Pass-through in Differentiated Product Market: The Case of U.S. Processed Cheese. *Journal of Industrial Economics, 55*, 32-48.

Kinoshita, J., N. Suzuki, and H. Kaiser, 2002. Explaining Pricing Conduct in a Product-Differentiated Oligopolistic Market: An Empirical Application of a Price Conjectural Variations Model, *Agribusiness* 18(4), 427-436.

Lopez, E. and R.A. Lopez, 2009. Demand for Differentiated Milk Products: Implications for Price Competition," *Agribusiness,* 25(4), 453-465.

Nazlioglu, S., 2011. World Oil and Agricultural Commodity Prices: Evidence from Nonlinear Causality. *Energy Policy*, 39, 2935-2943.

Nevo, A., 2001. Measuring Market Power in the Ready-to-Eat Cereal Industry, *Econometrica*, 69(2), 307-342.
Reboredo, J.C., 2012. Do Food and Oil Prices Co-Move? *Energy Policy*, 49, 456-467.

Reynaert, M. and F. Verboven, 2012. Improving the Performance of Random Coefficients Demand Models: The Role of Optimal Instruments.
Available at Social Science Research Network, http://ssrn.com/abstract=2084652.

Richards T.J., W.J. Allender, and S.F. Hamilton, 2012. Commodity Price Inflation, Retail Pass-through and Market Power. *International Journal of Industrial Organization*, 2012, vol. 30 (1), 50-57.

Runge C. F., J. Johnson and C.P. Runge, 2011. Better Milk than Cola: Soft Drink Taxes and Substitution Effects. Choices, 26(3), 26.

Sudhir, K. 2001. Competitive Pricing Behavior in the Auto Market: A Structural Analysis. *Marketing Science*, 20(1), 42-60.

U.S. Department of Agriculture. 2012. Per Capita Consumption of Selected Beverage by Type, from http://www.census.gov/compendia/statab/2012/tables/12s0215.pdf. Accessed on July 1, 2014.

U.S. Dept. of Labor. Bureau of Labor Statistics, 2013. Average Price Data. http://data.bls.gov/cgi bin/surveymost?ap. Accessed March 20, 2014.

U.S. Energy Information Administration, 2009–2011. Average Retail Price of Electricity to Ultimate Customers, from http://www.eia.gov/electricity/data.cfm#sales. Accessed on February 15, 2015.

Zhang, Z., L. Lohr, C. Escalante, and M. Wetzstein., 2010. Food versus Fuel: What Do Prices Tell Us? *Energy Policy* 38, 445-451.

Table 1. Summary of Milk Product Characteristics

Company/Brand	Price	Mk. Share	Fat	Lactose-Free	Size/Gallon
Dean Food/Garelick					
Garelick Farms 1	5.804	0.002	0	0	0.25
Garelick Farms 2	5.862	0.003	0.01	0	0.25
Garelick Farms 3	5.820	0.002	0.02	0	0.25
Garelick Farms 4	5.772	0.003	0.0325	0	0.25
Garelick Farms 5	4.726	0.007	0	0	0.5
Garelick Farms 6	4.727	0.009	0.01	0	0.5
Garelick Farms 7	4.730	0.008	0.02	0	0.5
Garelick Farms 8	4.711	0.008	0.0325	0	0.5
Garelick Farms 9	3.687	0.007	0	0	1
Garelick Farms 10	3.663	0.013	0.01	0	1
Garelick Farms 11	3.685	0.012	0.02	0	1
Garelick Farms 12	3.661	0.012	0.0325	0	1
Dean Food/Garelick F. o.t. M.					
Garelick Farms over the Moon 1	5.710	0.002	0	0	0.5
Garelick Farms over the Moon 2	5.713	0.001	0.01	0	0.5
Hood/Hood					
Hood 1	6.010	0.001	0	0	0.25
Hood 2	5.847	0.001	0.01	0	0.25
Hood 3	6.156	0.001	0.02	0	0.25
Hood 4	5.872	0.001	0.0325	0	0.25
Hood 5	4.615	0.006	0	0	0.5
Hood 6	4.663	0.008	0.01	0	0.5
Hood 7	4.688	0.007	0.02	0	0.5
Hood 8	4.713	0.008	0.0325	0	0.5
Hood 9	3.556	0.010	0	0	1
Hood 10	3.585	0.015	0.01	0	1
Hood 11	3.655	0.011	0.02	0	1
Hood 12	3.686	0.013	0.0325	0	1
Hood/ Hood Lactaid					
Hood Lactaid 1	9.229	0.001	0	1	0.25
Hood Lactaid 2	9.296	0.0003	0.02	1	0.25
Hood Lactaid 3	7.535	0.003	0	1	0.5
Hood Lactaid 4	7.490	0.002	0.01	1	0.5
Hood Lactaid 5	7.501	0.002	0.02	1	0.5
Hood Lactaid 6	7.419	0.001	0.0325	1	0.5
Hood/ Hood Simply Smart					
Hood Simply Smart 1	5.948	0.008	0	0	0.5
Hood Simply Smart 2	5.969	0.005	0.01	0	0.5
Private Label					
Private Label 1	5.347	0.001	0	0	0.25
Private Label 2	5.164	0.0004	0.01	0	0.25
Private Label 3	5.148	0.0002	0.02	0	0.25
Private Label 4	5.360	0.002	0.0325	0	0.25
Private Label 5	3.928	0.017	0	0	0.5
Private Label 6	3.840	0.019	0.01	0	0.5
Private Label 7	3.832	0.014	0.02	0	0.5
Private Label 8	3.842	0.018	0.0325	0	0.5
Private Label 9	6.663	0.001	0	1	0.5
Private Label 10	6.605	0.0003	0.02	1	0.5
Private Label 11	6.855	0.0002	0.0325	1	0.5
Private Label 12	2.932	0.060	0	0	1
Private Label 13	2.915	0.105	0.01	0	1
Private Label 14	2.929	0.073	0.02	0	1

Private Label 15	2.933	0.093	0.0325	0	1
Stonyfield Farm/Stonyfield Farm					
Stonyfield Farm 1	7.266	0.002	0	0	0.5
Stonyfield Farm 2	7.233	0.002	0.01	0	0.5
Stonyfield Farm 3	7.245	0.002	0.02	0	0.5
Stonyfield Farm 4	7.245	0.002	0.0325	0	0.5
Dean Foods/ The Org Cow of VT					
The Organic Cow of VT1	7.578	0.002	0	0	0.5
The Organic Cow of VT2	7.496	0.002	0.01	0	0.5
The Organic Cow of VT3	7.552	0.002	0.02	0	0.5
The Organic Cow of VT4	7.531	0.002	0.0325	0	0.5
The Organic Cow of VT5	6.327	0.001	0	0	1
The Organic Cow of VT6	6.328	0.001	0.01	0	1
The Organic Cow of VT7	6.366	0.001	0.0325	0	1

Table 2. Demand Estimation Results

Period A: On or Before March 2008				
	Mean Utility		Unobservables	
Variable	Mean	Standard Errors	Mean	Standard Errors
Price	-3.687*	(2.105)	-1.717*	(0.955)
Fat	-4.517	(5.557)	-10.865	(50.761)
Lactose-Free	-5.565***	(1.129)	2.333*	(1.969)
Size	2.221*	(1.216)	-2.113	(2.014)
Garelick Farms	2.035	(1.225)	-1.825	(1.924)
Garelick Farms o. t. Moon	-6.122	(9.256)	-7.024	(6.808)
Hood	1.669	(1.050)	-0.895	(1.345)
Hood Lactaid	-6.358	(13.986)	-11.901	(12.276)
Hood Simply Smart	2.818***	(0.830)	-0.794	(1.793)
PLs	2.725***	(0.878)	-0.385	(0.888)
Smart Balance	-1.949	(4.469)	3.514	(3.920)
Constant	-7.432***	(1.830)	-0.563	(4.345)
Month Fixed Effect	Yes			

Period B: After March 2008				
	Mean Utility		Unobservables	
Variable	Mean	Standard Errors	Mean	Standard Errors
Price	-1.724*	(0.945)	-0.970**	(0.457)
Fat	-0.195	(5.994)	1.549	(12.063)
Lactose-Free	-4.809	(8.019)	2.319	(2.150)
Size	3.936*	(2.370)	-0.755	(1.847)
Garelick Farms	0.373	(2.264)	2.464	(2.022)
Garelick Farms o. t. Moon	-1.747	(5.404)	-4.505	(4.470)
Hood	2.360**	(0.949)	-1.674	(1.545)
Hood Lactaid	3.008	(39.018)	3.085	(20.375)
Hood Simply Smart	2.381	(5.919)	-2.323	(4.871)
PLs	-0.208	(4.994)	-4.720	(3.941)
Stonyfield Farm	2.107*	(1.060)	-1.706	(1.734)
Constant	-11.158***	(2.864)	-0.755	(1.847)
Month Fixed Effect	Yes			

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Sample of Price Elasticities of Demand for Milk Products

Period A: On or Before March 2008

Product	GF 11	GF 12	Hood 10	Hood 12	Hood L. 3	PL 13	PL 14	PL 15	Sf Farm 1	The Org. C.
Garelick Farms 11	**-17.429**	0.067	0.097	0.001	0.005	0.080	0.065	0.081	0.115	0.212
Garelick Farms 12	0.004	**-25.415**	0.058	0.001	0.001	0.038	0.046	0.067	0.099	0.172
Hood 10	0.027	0.068	**-16.473**	0.001	0.003	0.073	0.083	0.053	0.070	0.193
Hood 12	0.033	0.081	0.090	**-17.980**	0.001	0.061	0.074	0.078	0.106	0.209
Hood Lactaid 3	0.029	0.084	0.066	0.001	**-23.651**	0.053	0.065	0.044	0.061	0.085
Private Label 13	0.034	0.075	0.081	0.001	0.001	**-15.964**	0.116	0.046	0.058	0.143
Private Label 14	0.035	0.077	0.075	0.001	0.001	0.060	**-14.508**	0.046	0.051	0.125
Private Label 15	0.027	0.060	0.053	0.001	0.002	0.042	0.048	**-22.606**	0.054	0.098
Stonyfield Farm 1	0.033	0.071	0.054	0.001	0.001	0.054	0.054	0.048	**-23.140**	0.096
The Org. Cow 1	0.027	0.074	0.044	0.001	0.008	0.049	0.065	0.025	0.031	**-14.755**

Period B: After March 2008

Product	GF 11	GF 12	Hood 10	Hood 12	Hood L. 3	PL 13	PL 14	PL 15	Sf Farm 1	The Org. C. 1
Garelick Farms 11	**-10.020**	0.008	0.052	0.021	0.028	0.025	0.025	0.021	0.039	0.081
Garelick Farms 12	0.014	**-7.961**	0.042	0.016	0.032	0.012	0.012	0.018	0.024	0.056
Hood 10	0.009	0.006	**-10.773**	0.008	0.019	0.031	0.031	0.011	0.020	0.054
Hood 12	0.011	0.008	0.037	**-11.238**	0.016	0.010	0.010	0.016	0.026	0.053
Hood Lactaid 3	0.038	0.040	0.074	0.008	**-8.099**	0.023	0.024	0.008	0.012	0.036
Private Label 13	0.012	0.008	0.031	0.010	0.017	**-9.713**	0.018	0.016	0.022	0.049
Private Label 14	0.009	0.007	0.030	0.014	0.016	0.018	**-9.626**	0.019	0.024	0.055
Private Label 15	0.011	0.007	0.033	0.018	0.018	0.008	0.009	**-11.015**	0.029	0.057
Stonyfield Farm 1	0.015	0.008	0.036	0.016	0.017	0.012	0.011	0.020	**-9.878**	0.054
The Org. Cow 1	0.017	0.015	0.062	0.020	0.044	0.024	0.024	0.022	0.042	**-10.555**

Table 4. Prices, Marginal Costs and Lerner Indexes On or Before March 2008

Company/Brand	Price	Price-MC	MC	Own-price Ela.	Lerner Index
Dean Food/Garelick					
Garelick Farms 1	5.117	0.294	5.239	-17.651	0.057
Garelick Farms 2	5.138	0.289	5.233	-17.968	0.056
Garelick Farms 3	5.012	0.283	5.073	-17.829	0.057
Garelick Farms 4	5.345	0.257	5.009	-22.161	0.048
Garelick Farms 5	5.100	0.257	3.995	-20.264	0.050
Garelick Farms 6	5.124	0.255	3.940	-20.182	0.050
Garelick Farms 7	5.603	0.255	4.785	-22.983	0.045
Garelick Farms 8	5.275	0.259	4.737	-19.974	0.049
Garelick Farms 9	5.666	0.257	5.042	-21.213	0.045
Garelick Farms 10	5.686	0.254	4.749	-21.934	0.045
Garelick Farms 11	4.441	0.260	4.778	-17.429	0.059
Garelick Farms 12	6.212	0.255	3.617	-25.415	0.041
Dean Food/Garelick F. o.t. M.					
Garelick Farms o. t. Moon 1	6.175	0.260	4.861	-25.199	0.042
Garelick Farms o. t. Moon 2	6.656	0.258	4.878	-27.210	0.039
Hood/Hood					
Hood 1	5.089	0.293	4.663	-18.855	0.058
Hood 2	5.030	0.337	4.576	-18.125	0.067
Hood 3	4.306	0.320	3.441	-16.067	0.074
Hood 4	4.363	0.319	3.430	-14.866	0.073
Hood 5	5.563	0.294	3.389	-22.534	0.053
Hood 6	5.211	0.289	3.374	-22.483	0.055
Hood 7	5.290	0.285	2.859	-22.610	0.054
Hood 8	5.679	0.285	2.863	-23.513	0.050
Hood 9	4.154	0.296	2.851	-16.868	0.071
Hood 10	4.111	0.292	2.820	-16.473	0.071
Hood 11	5.087	0.274	4.570	-18.279	0.054
Hood 12	5.139	0.278	4.625	-17.980	0.054
Hood/ Hood Lactaid					
Hood Lactaid 1	6.259	0.243	7.950	-24.401	0.039
Hood Lactaid 2	6.091	0.253	7.565	-23.613	0.042
Hood Lactaid 3	6.394	0.261	6.056	-23.651	0.041
Hood Lactaid 4	4.142	0.277	5.955	-12.221	0.067
Hood Lactaid 5	5.195	0.274	5.640	-20.968	0.053
Hood Lactaid 6	5.182	0.266	5.503	-20.810	0.051
Hood/ Hood Simply Smart					
Hood Simply Smart 1	5.292	0.257	2.922	-21.365	0.049
Hood Simply Smart 2	5.654	0.253	2.844	-22.373	0.045
Private Label					
Private Label 1	4.985	0.287	2.540	-19.079	0.058
Private Label 2	5.011	0.282	2.417	-18.720	0.056
Private Label 3	5.184	0.286	4.348	-20.581	0.055
Private Label 4	5.122	0.309	4.437	-17.991	0.060
Private Label 5	5.015	0.282	4.417	-18.379	0.056
Private Label 6	4.833	0.274	4.337	-17.917	0.057
Private Label 7	4.189	0.278	3.220	-15.258	0.066
Private Label 8	6.224	0.272	3.171	-21.062	0.044
Private Label 9	6.111	0.271	3.122	-24.829	0.044
Private Label 10	6.954	0.265	3.139	-27.642	0.038

Private Label 11	5.273	0.296	2.491	-24.334	0.056
Private Label 12	5.226	0.330	2.481	-23.132	0.063
Private Label 13	4.172	0.313	2.478	-15.964	0.075
Private Label 14	4.167	0.303	2.447	-14.508	0.073
Private Label 15	5.423	0.291	4.533	-22.606	0.054
Stonyfield Farm/Stonyfield Farm					
Stonyfield Farm 1	5.322	0.265	4.893	-23.140	0.050
Stonyfield Farm 2	5.321	0.254	4.882	-21.402	0.048
Stonyfield Farm 3	5.416	0.263	4.787	-22.120	0.049
Stonyfield Farm 4	4.528	0.279	3.701	-15.739	0.062
Dean Food/The Org. Cow of VT					
The Organic Cow of VT 1	4.505	0.282	3.562	-14.755	0.063
The Organic Cow of VT 1	5.302	0.280	3.433	-20.974	0.053
The Organic Cow of VT 1	5.281	0.283	3.413	-20.843	0.054
The Organic Cow of VT 1	6.264	0.260	2.754	-26.740	0.042
The Organic Cow of VT 1	6.147	0.257	2.695	-26.537	0.042
The Organic Cow of VT 1	6.544	0.258	2.681	-24.989	0.039
The Organic Cow of VT 1	4.171	0.302	2.681	-14.890	0.072

Table 5. Prices, Marginal Costs and Lerner Indexes After March 2008

Company/Brand	Price	Price-MC	MC	Own-price Ela.	Lerner Index
Dean Food/Garelick					
Garelick Farms 1	5.831	0.619	5.273	-10.506	0.106
Garelick Farms 2	5.702	0.604	5.293	-10.467	0.106
Garelick Farms 3	5.727	0.603	5.246	-10.348	0.105
Garelick Farms 4	5.869	0.612	5.194	-10.221	0.104
Garelick Farms 5	4.603	0.628	4.133	-8.408	0.137
Garelick Farms 6	4.614	0.635	4.156	-8.197	0.138
Garelick Farms 7	5.597	0.625	4.150	-9.981	0.112
Garelick Farms 8	5.471	0.619	4.105	-9.835	0.113
Garelick Farms 9	6.435	0.599	3.011	-11.126	0.093
Garelick Farms 10	6.286	0.616	2.982	-11.057	0.098
Garelick Farms 11	6.202	0.606	2.986	-10.020	0.098
Garelick Farms 12	4.526	0.622	2.929	-7.961	0.137
Dean Food/Garelick F. o.t. M.					
Garelick Farms o. t. Moon 1	5.606	0.617	5.474	-9.230	0.110
Garelick Farms o. t. Moon 2	5.699	0.596	5.530	-9.254	0.105
Hood/Hood					
Hood 1	5.661	0.679	5.349	-7.917	0.120
Hood 2	5.852	0.597	5.139	-10.620	0.102
Hood 3	5.257	0.598	4.257	-10.273	0.114
Hood 4	5.246	0.578	4.255	-10.717	0.110
Hood 5	5.908	0.572	4.272	-12.475	0.097
Hood 6	5.521	0.608	4.261	-9.663	0.110
Hood 7	5.894	0.586	3.383	-8.501	0.099
Hood 8	5.485	0.597	3.350	-8.732	0.109
Hood 9	4.473	0.599	3.370	-8.414	0.134
Hood 10	6.269	0.581	3.331	-10.773	0.093
Hood 11	6.443	0.585	5.345	-11.377	0.091
Hood 12	6.329	0.592	5.403	-11.238	0.094
Hood/ Hood Lactaid					
Hood Lactaid 1	5.682	0.592	5.494	-8.257	0.104
Hood Lactaid 2	5.704	0.628	5.477	-8.010	0.110
Hood Lactaid 3	4.588	0.584	4.441	-8.099	0.127
Hood Lactaid 4	4.592	0.601	4.469	-7.444	0.131
Hood Lactaid 5	5.837	0.521	4.422	-11.529	0.089
Hood Lactaid 6	5.675	0.528	4.401	-11.109	0.093
Hood/ Hood Simply Smart					
Hood Simply Smart 1	5.813	0.514	3.243	-11.145	0.088
Hood Simply Smart 2	5.736	0.506	3.215	-10.866	0.088
Private Label					
Private Label 1	4.486	0.645	3.095	-8.265	0.144
Private Label 2	4.521	0.658	3.076	-8.315	0.146
Private Label 3	5.426	0.653	5.421	-9.265	0.120
Private Label 4	5.485	0.647	5.454	-9.044	0.118
Private Label 5	6.498	0.558	5.418	-11.310	0.086
Private Label 6	6.452	0.556	5.370	-11.241	0.086
Private Label 7	6.227	0.587	4.297	-10.357	0.094
Private Label 8	4.523	0.586	4.228	-7.996	0.130
Private Label 9	5.691	0.604	4.301	-9.544	0.106
Private Label 10	5.472	0.585	4.180	-9.259	0.107
Private Label 11	5.666	0.596	2.840	-7.686	0.105

Private Label 12	5.720	0.557	2.962	-10.615	0.097
Private Label 13	5.197	0.578	2.977	-9.713	0.111
Private Label 14	5.241	0.571	2.967	-9.626	0.109
Private Label 15	5.866	0.589	5.539	-11.015	0.100
Stonyfield Farm/Stonyfield Farm					
Stonyfield Farm 1	5.877	0.619	5.584	-9.878	0.105
Stonyfield Farm 2	5.852	0.621	5.532	-8.039	0.106
Stonyfield Farm 3	5.847	0.599	5.472	-8.342	0.102
Stonyfield Farm 4	4.600	0.587	4.628	-8.298	0.128
Dean Food/The Org. Cow of VT					
The Organic Cow of VT 1	6.465	0.546	4.455	-10.555	0.085
The Organic Cow of VT 1	6.516	0.541	4.460	-11.829	0.083
The Organic Cow of VT 1	6.307	0.564	4.416	-11.496	0.089
The Organic Cow of VT 1	5.844	0.600	3.177	-8.237	0.103
The Organic Cow of VT 1	5.462	0.669	3.086	-8.171	0.122
The Organic Cow of VT 1	4.531	0.622	3.130	-7.500	0.137
The Organic Cow of VT 1	4.560	0.652	3.114	-7.255	0.143

Table 6. Parameter Estimates of the Milk for Marginal Cost Function

Independent Variables Log(marginal cost)	Before March 08	After March 08
Log(diesel)	0.363***	0.147***
	(0.130)	(0.016)
Log(electricity)	-0.183	0.673***
	(0.292)	(0.056)
Log(feed)	0.135***	0.088***
	(0.024)	(0.019)
Log(Size)	-0.439***	-0.227***
	(0.011)	(0.008)
Fat	0.427	0.402
	(0.660)	(0.279)
Constant	0.429	-0.689***
	(0.779)	(0.169)
Manufacturer Brand (Hood)	0.173***	-0.148***
	(0.013)	(0.013)
PLs	-0.058**	-0.677***
	(0.027)	(0.018)
Organic	0.525***	-0.072***
	(0.015)	(0.025)
Month Dummy	Yes	Yes
Year Dummy	Yes	Yes
R2	0.5	0.79

Table 7. Estimated Pass-through Rates

Company/Brand	Pass-through Rate before March 08	Pass-through Rate after March 08
Dean Food/Garelick		
Garelick Farms 1	0.340	0.191
Garelick Farms 2	0.340	0.192
Garelick Farms 3	0.330	0.190
Garelick Farms 4	0.326	0.189
Garelick Farms 5	0.260	0.150
Garelick Farms 6	0.256	0.151
Garelick Farms 7	0.311	0.151
Garelick Farms 8	0.308	0.149
Garelick Farms 9	0.328	0.109
Garelick Farms 10	0.309	0.108
Garelick Farms 11	0.310	0.108
Garelick Farms 12	0.235	0.106
Dean Food/Garelick F. o.t. M.		
Garelick Farms o. t. Moon 1	0.317	0.185
Garelick Farms o. t. Moon 2	0.318	0.187
Hood/Hood		
Hood 1	0.304	0.180
Hood 2	0.299	0.173
Hood 3	0.225	0.144
Hood 4	0.224	0.144
Hood 5	0.221	0.144
Hood 6	0.220	0.144
Hood 7	0.187	0.114
Hood 8	0.187	0.113
Hood 9	0.186	0.114
Hood 10	0.184	0.112
Hood 11	0.291	0.167
Hood 12	0.294	0.169
Hood/ Hood Lactaid		
Hood Lactaid 1	0.506	0.172
Hood Lactaid 2	0.481	0.172
Hood Lactaid 3	0.385	0.139
Hood Lactaid 4	0.379	0.140
Hood Lactaid 5	0.359	0.139
Hood Lactaid 6	0.350	0.138
Hood/ Hood Simply Smart		
Hood Simply Smart 1	0.186	0.102
Hood Simply Smart 2	0.181	0.101
Private Label		
Private Label 1	0.162	0.097
Private Label 2	0.154	0.096
Private Label 3	0.261	0.170
Private Label 4	0.266	0.171
Private Label 5	0.265	0.170
Private Label 6	0.260	0.168
Private Label 7	0.193	0.134
Private Label 8	0.190	0.132
Private Label 9	0.187	0.135
Private Label 10	0.188	0.131
Private Label 11	0.149	0.089

Private Label 12	0.149	0.093
Private Label 13	0.149	0.093
Private Label 14	0.147	0.093
Private Label 15	0.257	0.186
Stonyfield Farm/Stonyfield Farm		
Stonyfield Farm 1	0.277	0.187
Stonyfield Farm 2	0.276	0.186
Stonyfield Farm 3	0.271	0.184
Stonyfield Farm 4	0.209	0.155
Dean Food/The Org. Cow of VT		
The Organic Cow of VT1	0.202	0.150
The Organic Cow of VT1	0.194	0.150
The Organic Cow of VT1	0.193	0.148
The Organic Cow of VT1	0.156	0.107
The Organic Cow of VT1	0.153	0.104
The Organic Cow of VT1	0.152	0.105
The Organic Cow of VT1	0.152	0.104
Two sample t-test	14.06	