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COMPETITION BETWEEN PRIVATE LABELS AND NATIONAL BRANDS: EMPIRICAL EVIDENCE FROM HOMESCAN DATA ON FLUID MILK MARKETS

For the degree of Master of Science

Is approved by the final examining committee:

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Richard J. Volpe	

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COMPETITION BETWEEN PRIVATE LABELS AND NATIONAL BRANDS: EMPIRICAL EVIDENCE FROM HOMESCAN DATA ON FLUID MILK MARKETS

A Thesis
Submitted to the Faculty
of
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by
Jeffrey S. Young

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ABSTRACT

Young, Jeffrey S., Purdue University, December 2014. Competition between Private Labels and National Brands: Empirical Evidence from Homescan Data on Fluid Milk Markets. Major Professor: Joseph V. Balagtas.

The purpose of this study is to empirically examine the nature of the pricing relationship between private labels (or "store brands") and national brands. To accomplish this, we control for the exogenous variation in the farm price of a commodity that serves as the main agricultural input common to both private labels and national brands (any shocks to this farm price will pass through to both retail prices – private label and retail). The product of choice is fluid milk, as the farm price of milk comprises a large share of producer and retailer cost.

Two examples of underlying theories concerning this relationship are that (1) the introduction of private labels into a market lowers relative national brand prices, and (2) the introduction of private labels raises the relative national brand prices. The intuition following these two theories about private label/national brand competition tells us the patterns we should look for in the farm-to-retail price transmissions – whether relative national brand prices rise or fall. Hence, the models we estimate are standard price transmission models, each appropriate under specific assumptions about the data.

We obtain results that are inconsistent with either of the chosen theories. Furthermore, the results are robust across model specification. Within the results, we do observe that for small number of markets, the price transmission patterns for private labels are statistically different from those of national brands. Using Chow tests, these markets can be identified and set aside for further investigation.

Finally, we estimate the models again using private label retail prices from retailers for whom private labels are a relatively larger share of sales, and private label prices from retailers for whom private labels are a relatively lower share of sales. On average, we observe no difference in price-setting by retailers who feature national brands and those who don’t, which is consistent with the preliminary findings.

CHAPTER 1. INTRODUCTION

1.1 Background

In the latter half of the 20th century, the larger food retailers introduced their own versions of the products they were selling. Typically referred to as “store brand” or, as in this paper, “private label” goods, they were put under the store’s own label and were priced considerably lower than the branded products (firms can avoid double marginalization with private labels, which is not the case with national brands).

There has been much speculation about the effect this introduction of private label competition has had on the pricing of nationally branded products. Certainly, it gives more options to consumers, and produces savings for those who view the two as substitutes of one another. However, no single speculation or theory regarding this effect has emerged.

1.2 Previous Studies

Two predominant competing views of this relationship persist: One view, which may be termed the “competitive view”, is that lower-priced private labels provide an incentive for the national brands to lower their prices in order to remain competitive. As a consequence, retail prices for national brands are lower under private label competition than they would be without it.

A more recent view, to which we refer as the "market segmentation view"[1], introduced by Ward et al. (2002) is that, if anything, the introduction of private labels leads to higher branded prices. Ward et al. used IRI scanner data from grocery stores to estimate the effects of private label prices on the pricing of national brand food products and found that branded prices actually rose with the introduction of private labels. A possible explanation is that since retailers earn higher margins on their own brands[2], they have an incentive to induce buyers to switch from national brands. It is the retailers who have the ultimate pricing power, so they have an incentive to raise branded prices (regardless of what the branded manufacturer does), causing some customers to switch and raising the margin on those with more inelastic demands, who do not switch (Perloff et al., 2012).

Steiner (2004) investigated the nature and benefits of the competition between private label and national brand prices. His main argument is that it is the retailers who set the ultimate shelf price; thus, in order to make their private label goods more appealing to consumers who may consider private label goods to be of lower quality than branded goods, they exercise their pricing power to force national brand manufacturers to lower their prices. Furthermore, the study finds that consumer welfare is maximized when private labels and national brands are competing, rather than when one is more dominant than the other. Three incentives are presented as the primary reasons retailers

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[1] The term "segmentation" may bring about some ambiguity. By this, we do not mean that the market is split into two new markets, but rather the pool of consumers is segmented into those with relatively elastic demand and those with relatively inelastic demand. By retailers forcing consumers to face higher branded prices, those consumers who take these prices as given and continue to purchase branded products, they identify themselves as consumers who are less price-sensitive.

[2] Because of double marginalization, retailers have no manufacturer-set markups to pay on private label goods, so the retailers' margin from retail markup can be larger while still keeping the private label price lower than the branded price.

create private label products to compete with national brands: (1) Short term subsidization of private label products could actually be profitable in the long run, (2) Sale prices for private label goods are more profitable than promoting national brands, and (3) Retailers that have a strong, well-established private label possess more leverage with national brand manufacturers to barter for price concessions on the branded products sold to them by those manufacturers.

Wolinsky (1987) looked at a basic duopoly model concerning two brands and the competition between them. To begin, he examined the net surplus (benefit less the cost of obtaining one unit of the preferred brand) of an individual. With this being established, he claimed (and proves in the appendix) that for a concave utility function, there exists a symmetric equilibrium, and characterizes it in a system of three equations. Post-analysis, the study concluded that retailers market both national brand and private label products in order to price discriminate, exploiting consumers' imperfect information about products as well as their variation in preferences. When different firms produce their own brand, this is found to be consistent with what results from non-cooperative interactions between the firms.

While studying the interactions between privately-labeled and nationally-branded pricing using data from the recession in 2007-2009, Volpe (2011) found that, on average, private label foods are priced 23% lower than the national brand equivalents, both with and without promotions or sales. Volpe also found that prices of private labels and national brands were converging, which seems to support the competitive view of the relationship between private labels and national brands.

1.3 Empirical Approach

Given that the effect of private labels on the prices of nationally branded equivalents is theoretically ambiguous, we turn to the data to shed empirical evidence on the interactions between prices of private labels and national brands. The preferred approach to evaluating this relationship would be to examine national brand prices before and after private labels' appearance, but the data showing prices before private labels' introduction is unavailable to us. In other words, we do not have any exogenous variation in the national brand prices due to the prevalence of private labels. Another direct method would be analyzing how the prices of national brand products differ across stores and cities with and without private labels. However, private labels are ubiquitous throughout all aspects of our data, and we cannot obtain any meaningful cross-sectional variation in national brand prices.

Our empirical application is to the fluid milk market in select U.S. cities, using data from the Nielsen Homescan panel. Building on the literature on farm-retail price transmission, our empirical specification models the responses of prices of national brands and private labels to shocks to farm prices of milk. We then draw inference on competition between national brands and private labels from the responses of retail prices to plausibly exogenous, common shocks to the price of the main agricultural input.

CHAPTER 2. DATA

2.1 Retail and Farm Milk Prices

We use data from two sources. All retail price data are from the Nielsen Homescan data set, which enlists households[3] to record all grocery purchase data at an item level with corresponding price, brand, and store information. In this paper we consider fluid milk in gallons, the most common fluid milk volume, from 2004-2010. The farm prices are the regulated Class 1 price that milk plants must pay for milk sold in fluid uses. The original data are from USDA Agricultural Marketing Service; we extracted these data from Prof. Brian Gould's *Understanding Dairy Markets* website, which collects dairy data from various public agencies.

Nielsen Homescan data is from a nationally representative sample covering 52 markets (similar to Metropolitan Statistical Areas) and 9 remaining/regional markets to cover the continental US[4]. The retailer types were restricted to supermarkets (or supercenters), groceries, and food clubs. We excluded health food stores, pharmacies, gas stations, and convenience stores because the price-setting policies of such establishments depend on other additional characteristics that would make these retailers incomparable to the retailers we chose to examine in our data.

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[3] Due to oversampling in some markets, the number of households in a city does not reflect population directly; for instance, in 2010, the number of households in a market ranged from 272 households in Des Moines to 1,991 households in Chicago.

[4] With between 20-50 counties in metropolitan areas. Only the subset of 52 US cities is used in the analysis.

By far the most common milk product in the data was 2%, non-organic, non-flavored, fluid milk sold in gallons. This dataset contained nearly 3 million observations. The second most popular specification was non-organic, non-flavored, fluid skim milk in gallons – about 2 million observations. For reasons set forth below to further improve on this, we aggregated all milk into gallons – ignoring any differences across fat content – for our computations. This new dataset contained about 6 million observations. We do not believe this aggregation causes any problems because the price of the aggregated milk types differs very little from that of two percent milk (Figure 2.1), the most commonly purchased milk type in the data.

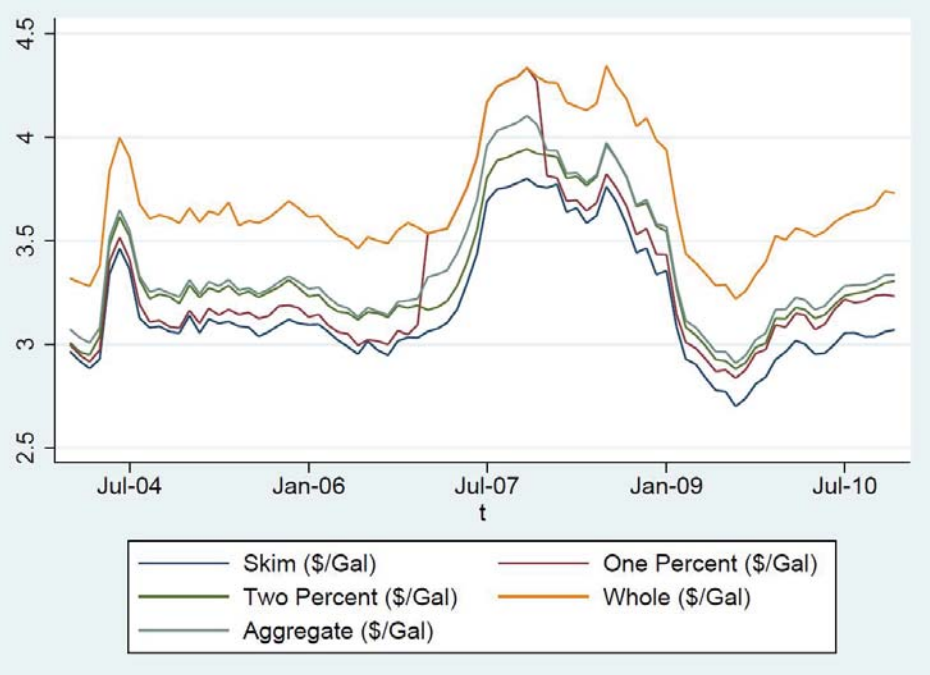

Figure 2.1. Average Monthly Retail Prices ($/FlOz) for skim, 1%, 2%, and Whole Milk sold in Gallons and all Milk sold in Gallons, United States, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan Data).

2.2 Data Subsets

Ideally, we would have price series for each brand sold in each store for all 52 markets, including the series of each store's private label prices. However, due to data limitations[5], we performed our analysis at the market level. That is, we aggregate all private label milk prices from all retailers in a market and create an average monthly price for private label milk for each market. The same process is followed for branded milk, aggregating all non-private label brands from all stores in each market, computing the average monthly national brand milk price for every market. To calculate these monthly average retail price series, we restricted the computation process in that a market must have at least 5 observations for private label sales and 5 observations for branded sales in each month. With this threshold in place, 51 of the 52 markets qualified for our analysis[6]. In these 51 markets, we have a total of 3 monthly time series – the average private label retail price for that market, the average national brand retail price for that market, and the class I farm price for the relevant USDA federal milk marketing order.

As a follow-up, we look on a finer level by examining the response of private label milk prices from different retailers. For each firm that is in a market, the retail price of that firm includes all branches of that firm within that particular city. To this end, we select all retailers in all markets who have at least 5 observations per month of private label milk sales. This gives us a total of 240 retailers, which we subset into 120 retailers who sell relatively more national brands and 120 who sell relatively fewer brands. These

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[5] Because private labels are so dominant in the fluid milk market, our data has drastically fewer observations for transactions of branded milk. Hence, with this data, we are unable to perform our analysis at the brand-firm level.

[6] San Diego had several instances of no observations of branded milk in 2005-2006.

240 retailers are scattered throughout 49 of the 52 total markets (US cities) in the Nielsen data; each city contains 5 different retailers from this group on average – Philadelphia and Washington, DC topping the list with 11 and 10 different retailers, respectively.

We convert all prices to dollars per fluid oz.[7] in order to directly compare the retail and farm prices. The resulting data set consists of 84 monthly observations on each of the major private labels and national brands in each of our regional markets. Our time units are in months because the farm price changes monthly.

To exclude organic milk from our data, we set all indicator variables to delete any observations that might be organic milk. However, there were some bugs in the data that brought in outliers that could be organic milk accidentally recorded as non-organic[8]. There were also outliers where the price had been recorded as $0.00, but no coupon was used, and no promotion was offered by the store where the milk was purchased. In order to counteract the problem of these outliers – both high and low – we removed the top 5% and the bottom 5% of the prices for every market, and then averaged the data as we had intended, thus virtually eliminating the issue of outliers.

Table A1 presents simple, firm-level summary statistics for the Chicago and Boston markets. Prices of national brands are, on average, higher than those of the corresponding private labels. The same is true on the market level (Figures 2.2, 2.3), as well as the national level (Figure 2.4).

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[7] Since the prices recorded in the Homscan data are prices paid by the consumer, we factored in any promotions and added back any coupon values to the price, ergo obtaining the actual shelf price set by the store in which the milk was purchased.

[8] These observations had exceedingly high prices consistent with those of the organic milk observations.

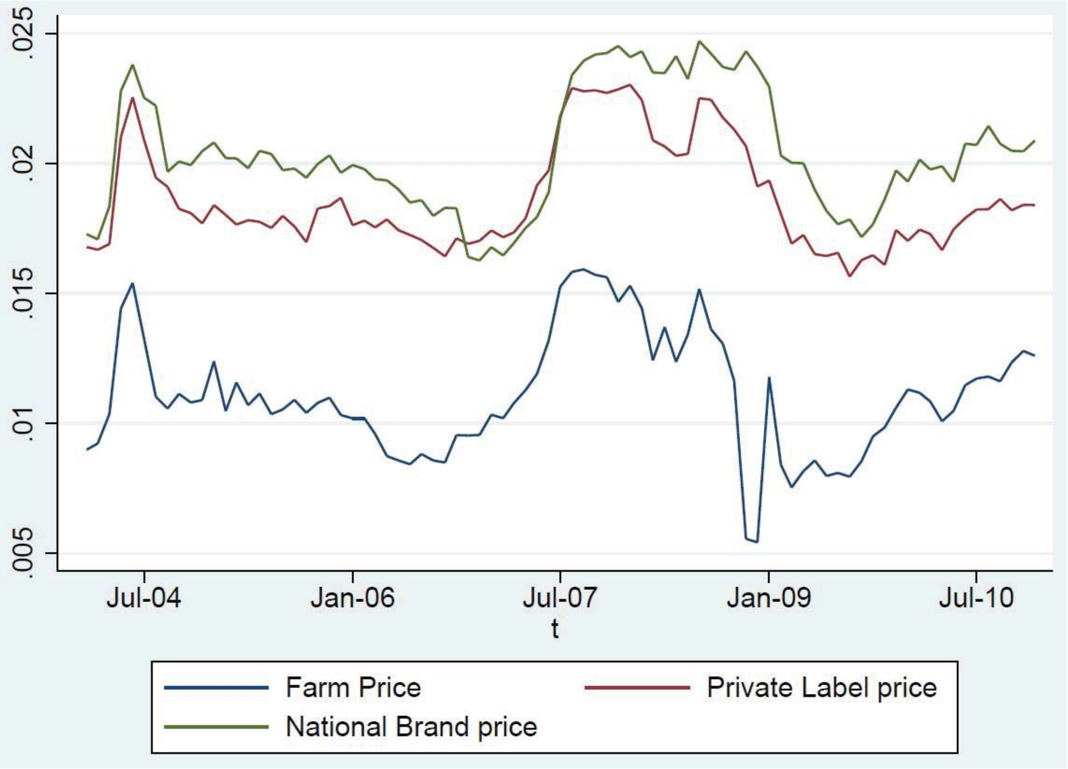

Figure 2.2: Average Monthly Retail Prices and Regional Rarm Price ($/FlOz) for Milk sold in Gallons, Chicago, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan and USDA-NASS Data).

Notice that, in Figure 2.2, the average private label retail price very briefly jumps above the average national brand retail price in Chicago, but then returns back to the original pattern of the national brand price remaining the highest and continues in that fashion for the remainder of the period.

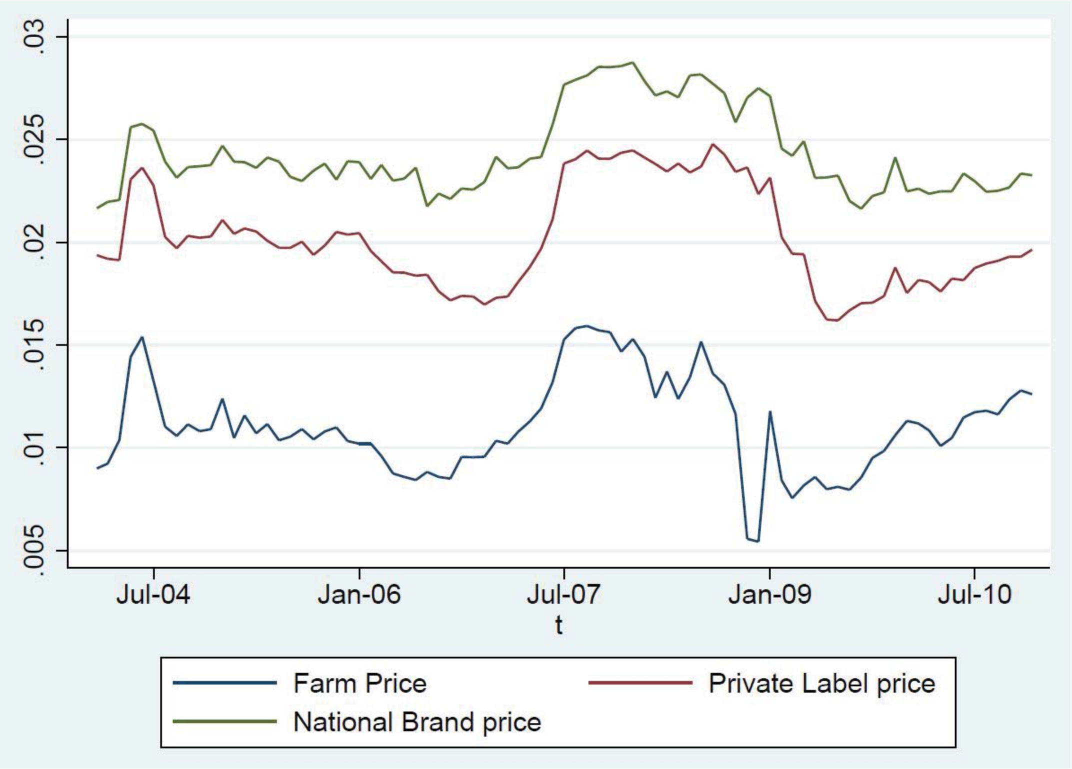

Figure 2.3: Average Monthly Retail Prices and Regional Farm Price ($/FlOz) for Milk sold in Gallons, Minneapolis, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan and USDA-NASS Data).

In Figure 2.3, we see the same pattern holding more consistently in Minneapolis, as well as in several other markets (seen in Figures B1-B3), and on a national level (Figure 2.4). Table A2 verifies this pattern in a majority of US cities given by the summary statistics listed at the market level.

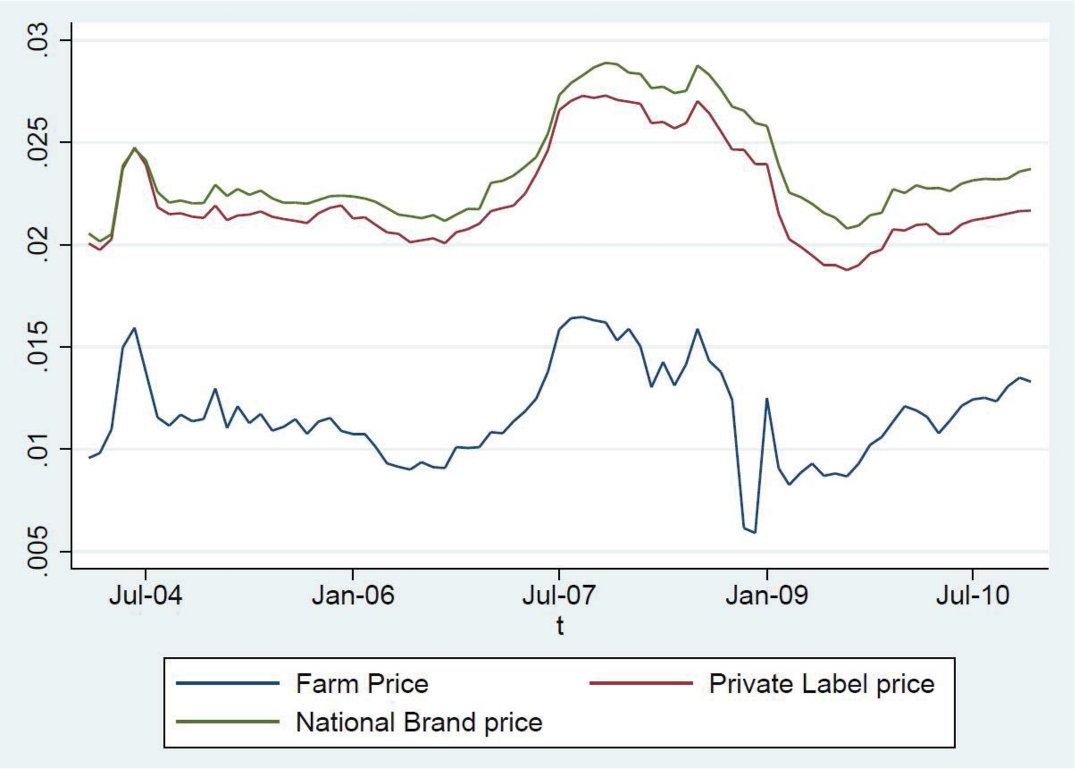

Figure 2.4: Average Monthly Retail Prices and Regional Farm Price ($/FlOz) for Milk sold in Gallons, United States, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan and USDA-NASS Data).

We now turn to an econometric analysis for a more formal exploration of the relationships among prices of national brands and private labels.

CHAPTER 3. METHODOLOGY

3.1 Empirical Motivation

Our goal is to assess the two competing theories on competition between private labels and national brands by examining the effects of (exogenous) changes in the farm price of milk on the changes on retail prices of private labels and national brands. More generally, we investigate the existence of strategic pricing behavior of retailers.

If the competitive view is correct, then we would predict a pattern of pass-through that causes prices of national brands and private labels to converge. That is, if the retail prices respond to farm price shocks in a way that lowers the relative national brand price, then this is certainly consistent with this view. However, if the market segmentation view holds, then we would expect a pattern of pass-through that drives up the price of the national brand relative to that of the private label. Either of these require different price transmission patterns for private labels and national brands.

As part of his study of pass-through of increases in commodity and wholesale prices to retail prices, Leibtag (2009) estimated the relationship between farm, wholesale, and retail prices for a range of food items. For fluid milk he finds that between 5% and 18% of upstream price-increases are passed on to retail prices, with a lag of up to five months. Therefore, our lag length of choice follows the convention of 5 months. However, Leibtag does not address the potential for differential price responses for national brands and private labels.

Given that farm prices can be transmitted asymmetrically (ie, farm price increases are passed through to retail prices differently than farm price decreases), Capps and Sherwell (2007) investigate using two standard asymmetric price transmission models. The first is the standard Houck (1977) model developed as a test for asymmetry, and the second is a modification of this model that allows for cointegration between the retail and farm price series.

While Capps and Sherwell (2007) use only two pre-specified models to test for asymmetry, von Cramon-Taubadel and Loy (1996) formulate a survey of models that are used to detect asymmetric price transmission. Two of the models used in the Capps and Sherwell (2007) study are presented in detail in the survey.

3.2 Time-Series Econometric Modelling

Because our data is purely time-series, any model we build will depend on time-series properties such as stationarity, serial correlation, cointegration, etc. Standard unit root tests on the natural logs of the price series indicated that most of the series followed unit root processes. However, to proceed under the assumption that all prices follow unit root processes is risky. Unit root tests can often be inconclusive; hence, we construct multiple models, each of which is appropriate under its own unique set of assumptions about the data generating processes.

Each equation is estimated 51 times – once for each market; also, each model is estimated twice in each market – once for private label retail prices, once for national brand prices. In all cases, the extent of the difference between the two is tested using Chow tests. We also use the Swamy method of random coefficients – as presented in Greene (2003) – to estimate the equations.

3.2.1 Model 1 – Stationary Time Series

Our first model is in levels, operating under the key assumption of no unit root processes. It takes the form

$$(1) \qquad P_t^i = \beta_0^i + \beta_1^i P_t^{farm} + u_t^i$$

where

$$i \in \{Private\ Label, National\ Brand\}.$$

For this model, we regress the current retail price on the current farm price to estimate the contemporaneous effect of changes in the farm price. With this, we can determine whether private labels or national brands are more responsive to these farm price shocks.

3.2.2 Model 2 – Introduce Asymmetry

One should note that this symmetric transmission model assumes that the response to increases in the farm prices is equivalent to the response to decreases in the farm price. However, if farm prices are transmitted asymmetrically to retail prices, then increases in the farm price will have a different effect than decreases in the farm price.

We allow for this using the standard Houck (1977) model which was developed primarily to test for asymmetry

$$(3) \qquad \Delta^{*}P_{t}^{i}=\alpha_{0}^{i}t+\sum_{m=0}^{4}\alpha_{m}^{i(+)}\Delta^{(+)}P_{t-m}^{farm}+\sum_{n=0}^{4}\alpha_{n}^{i(-)}\Delta^{(-)}P_{t-n}^{farm}+\nu_{t}^{i}$$

where

$$i\in\{Private\ Label, National\ Brand\},$$

$$\Delta^{(+)}P_{t}^{farm}=\begin{cases}P_{t}^{farm}-P_{t-1}^{farm}, if\ P_{t}^{farm}>P_{t-1}^{farm}\\ 0, otherwise\end{cases},$$

$$\Delta^{(-)}P_{t}^{farm}=\begin{cases}P_{t}^{farm}-P_{t-1}^{farm}, if\ P_{t}^{farm}<P_{t-1}^{farm}\\ 0, otherwise\end{cases}.$$

In the standard Houck model, the dependent variable $\Delta^{*}P_{t}^{i}$ is the sum of the first differenced price P_{t}^{i} across all time periods t; simplifying the series, the middle terms cancel each other out, leaving us with the current price P_{t}^{i} and the initial price P_{0}^{i}. In other words, the dependent variable $\Delta^{*}P_{t}^{i}$ is simply the current price less the initial price, ie, $\Delta^{*}P_{t}^{i}=P_{t}^{i}-P_{0}^{i}$ for each time period t.

With this model, we can estimate the pass-through of both increases and decreases in the farm price to the retail prices. Another advantage of this specification is that we can perform joint F-tests for asymmetric price transmission. For this model, we make no assumptions about whether the series follow unit root processes as the variables are in differences by model specification. However, we are assuming that no price series are cointegrated with one another.

3.2.3 Model 3 – Asymmetry & Cointegration

This leads us to the third and final model, developed by von Cramon-Taubadel & Loy (1996) which takes the Houck (1977) model and allows for cointegration between the retail and farm prices. In this case, we are assuming nonstationary time series and cointegration between the retail and farm prices.

The competitive view of private label and national brand competition suggests that prices of prices of private labels would be more responsive to changes in farm prices, as national brand prices are being restrained from rising too much under the competition. Furthermore, if private labels make brands more competitive, then we might expect less asymmetry for brands since competitive behavior could imply no asymmetry.

The market segmentation view suggests that retailers would use changes in the farm price to increase the price of national brands relative to the price of private labels. In order to accommodate the market segmentation view, the standard error correction model requires some modification. Following Capps and Sherwell (2007), we extend the error correction with Houck-type decompositions of lagged prices and the lagged error correction term. The resulting model is as follows:

$$(4) \qquad \Delta^{*} P_t^i = \gamma_0^i t + \sum_{m=0}^{4} \gamma_m^{i(+)} \Delta^{(+)} P_{t-m}^{farm} + \sum_{n=0}^{4} \gamma_n^{i(-)} \Delta^{(-)} P_{t-n}^{farm} + \delta^{(+)} ECT_t^{i(+)} + \delta^{(-)} ECT_t^{i(-)} + \epsilon_t^i$$

where

$$i \in \{Private\ Label, National\ Brand\},$$

$$\Delta^{(+)} P_t^{farm} = \begin{cases} P_t^{farm} - P_{t-1}^{farm}, if\ P_t^{farm} > P_{t-1}^{farm} \\ 0, otherwise \end{cases},$$

$$\Delta^{(-)}P_t^{farm} = \begin{cases} P_t^{farm} - P_{t-1}^{farm}, if\ P_t^{farm} < P_{t-1}^{farm} \\ 0, otherwise \end{cases},$$

$$ECT_t^{i(+)} = \begin{cases} ECT_t^i, if\ ECT_t^i > 0 \\ 0, otherwise \end{cases},$$

$$ECT_t^{i(-)} = \begin{cases} ECT_t^i, if\ ECT_t^i < 0 \\ 0, otherwise \end{cases},$$

and ECT_t^i is the lagged residual of the i^{th} cointegrating regression, or $u_{t-1}^i = P_t^i - \beta_0^i - \beta_1^i P_t^{farm}$ from equation (1). The dependent variable $\Delta^* P_t^i$ is the same "Houck" differenced price as in the previous model (initial retail price subtracted from current retail price).

The error correction term is the speed of adjustment of the long-run equilibrium relationship (also called the cointegrating regression, seen above) between the retail and farm prices. If the error correction term is negative in period t, then we know that, according to the long-run equilibrium between the farm and retail prices, the retail price is below equilibrium and/or the farm price is above equilibrium. Including the error correction terms accounts for the cointegration that seems to be present in the farm and retail prices, as seen in figures 2, 3, and 4. We also benefit in that we segment the error correction term into positive and negative adjustments – another test for asymmetry.

In order to assess farm-retail price transmission, we use the estimated error correction model to compute and plot the impulse response functions showing changes over time to the prices of private labels and national brands in response to a shock to the class 1 farm price.

For a follow-up analysis, we use the firm-level data and again estimate all of our models to seek evidence of pricing strategy across private labels by retailers. If any such strategy that is consistent with either of the competitive view or the market segmentation view exists, then it is reasonable to expect it to show in the responses of the different types of retailers – those who largely feature national brands and those who do not. If private labels compete in any way, then retailers without branded milk will have no such pricing strategy show itself in the model.

CHAPTER 4. RESULTS

4.1 Model 1 Results (PL vs NB)

When we estimate the first model, we detect evidence of serial correlation in nearly every market using Breuch-Godfrey tests. Hence, this prompted some re-specification of the model, specifically, including the lagged dependent variable and several lags of the independent variable

$$(2) \qquad P_t^i = \beta_0^i + \beta_1^i P_{t-1}^i + \sum_{j=0}^{5} \beta_{2_j}^i P_{t-j}^{farm} + u_t^i$$

where

$$i \in \{Private\ Label, National\ Brand\}.$$

With this new specification, we can account for the timing of pass-through – following the fashion of Leibtag (2009) – and also calculate the long-run effect $\frac{\beta_{2_0}^i+\beta_{2_1}^i+\beta_{2_2}^i+\beta_{2_3}^i+\beta_{2_4}^i+\beta_{2_5}^i}{1-\beta_1^i}$ of changes in the farm price on the i^{th} retail price. The R^2 for OLS ranges from 0.84 to 0.98 for the model run on private labels, and 0.69 to 0.95 for the model run on national brands. The R^2 for the Swamy method is 0.96 for private labels and 0.94 for national brands.

Table 4.1: Model 1 Parameter Estimates (Equation (2) using PL and NB prices by market).

	Private Label				National Brand			
Variable	Mean	$t > 2$	$t < -2$	Random	Mean	$t > 2$	$t < -2$	Random
$Retail_{t-1}$	0.863	51	0	0.874	0.841	51	0	0.856
$Farm_t$	0.296	49	0	0.295	0.262	46	0	0.256
$Farm_{t-1}$	-0.154	0	17	-0.157	-0.100	0	12	-0.103
$Farm_{t-2}$	0.010	1	0	0.006	-0.003	1	0	-0.003
$Farm_{t-3}$	0.006	2	2	0.006	0.028	2	1	0.026
$Farm_{t-4}$	0.020	1	1	0.018	0.005	2	0	0.003
$Farm_{t-5}$	-0.018	0	1	-0.021	-0.002	0	2	-0.005
$Farm_{all}$	1.158	42	0	1.162	1.195	43	0	1.213

Table 4.1 presents the results of each equation – model 1 for private label prices, and model 1 for national brand prices. Each equation was estimated 51 times (once for each market) and Swamy random coefficient estimation (Greene 2003) was used to compute the (weighted) average effect across the 51 markets (under the column labelled “Random”). This table also shows an unweighted average, or the mean of the 51 markets (under the column labelled “Mean”). The Swamy random coefficient estimation was chosen as it is a more conservative estimate than OLS (and more accurate) with regards to statistical significance. The estimation across all markets is, at its essence, a weighted average of the individual OLS estimates where each estimate is weighted by its variance. This procedure estimates the mean effect while still accounting for these random individual noise components in each market. Written in equation form, the assumption is $\hat{\beta}_{i_k} = \beta_k + e_{i_k}$ where β_k is the mean of the k^{th} coefficient, $\hat{\beta}_{i_k}$ is the estimate of that mean in market *i*, and e_{i_k} is a mean-zero random noise variable unique to the same market. So the coefficient in market *i* is assumed to be the true mean of the coefficient

plus random noise from market *i.* The advantage of also estimating the price transmission parameters using Swamy is that the estimated variances are usually larger than if we use pooled OLS instead, hence obtaining a more conservative estimate.

The effect of the current farm price is positive and significant (at the 5% significance level) in 49 out of 51 markets for private labels, and 46 out of 51 markets for national brands, as indicated by the column “$t > 2$”, and never negative and significant, as indicated by the column “$t < -2$”. Comparing this to the number of significant markets for all other parameters, the majority of the farm price is passed through contemporaneously, so the coefficient on the current farm price is the parameter of interest. Also seen in table 4.1, for a \$1 increase in the farm price of milk at time *t*, we see a \$0.29 increase in the private label retail price, compared to a \$0.25 increase in the national brand retail price. This tells us that, at least in the short-run, farm price shocks impact private label prices and national brand prices in a very similar way (although the effect on private labels is slightly larger), which is inconsistent with any theory stating that retailers use private labels as a strategic device against national brand products.

Now we turn to the long-run problem. The long-run effect of changes in the farm price on private labels is, on average, 1.16 (statistically significant in 42 of the 51 markets), compared to an average value of 1.19 for national brands (statistically significant in 43 of the 51 markets)[9]. Similar to the short-run, the two effects are still very close to one another. In fact, Chow tests followed by use of the Delta Method to compare

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[9] Recall that the null hypothesis for the long-run problem in this model is $H_0: \frac{\beta_{20}^i+\beta_{21}^i+\beta_{22}^i+\beta_{23}^i+\beta_{24}^i+\beta_{25}^i}{1-\beta_1^i} = 0$, where $i \in \{Private\ Label, National\ Brand\}$; this non-linear hypothesis requires the Delta Method to test for significance, rather than a simple joint F-test, such as those used in the following two models.

the long-run price transmissions reveal in Table A12 that none of the 51 markets were significantly different at any conventional significance level. Hence, in the long-run, also, a change in the farm price affects private label retail prices by nearly the same amount as it affects national brand prices.

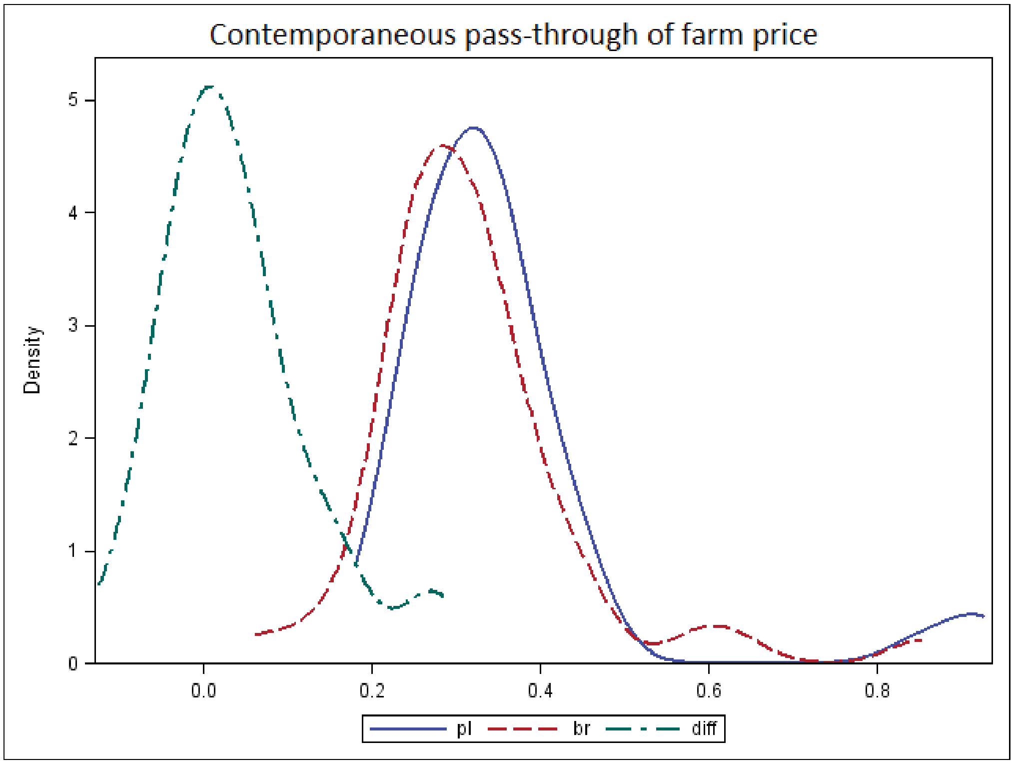

Figure 4.1: Kernel Density Plot for $\beta_{2_1}^{Private\ Label}$(“pl”), $\beta_{2_1}^{National\ Brand}$(“br”), and $\beta_{2_1}^{Private\ Label} - \beta_{2_1}^{National\ Brand}$(“diff”).

As seen in figure 4.1, the kernel density estimations of the contemporaneous effect (the coefficient on the current farm price) show that the distribution for private labels largely overlaps that of national brands (“pl” and “nb”, respectively). Furthermore, their difference (“diff” in the figure) is centered very close to 0.

Re-estimating the model using seemingly unrelated regression equations, the coefficients differed by less than half a cent[10], and R^2 ranges from 0.04 to 0.88. However, SUR is necessary to capture the cross-equation error correlation when conducting Chow tests to assess the responses of private labels and national brands. The Chow tests indicated that the effect is significantly different for 8 markets at the 10% level or better, as seen in Table A3. Hence, we can conclude that, for a large majority of markets, the farm price is transmitted equivalently to private labels and national brands when assuming this model specification.

4.2 Model 2 Results (PL vs NB)

With this model, we allow for asymmetry in the pass-through of farm prices. Table 4.2 presents the estimates and the calculated long run effects for increases and decreases in the farm price, $\alpha_{2_0}^{i(+)} + \alpha_{2_1}^{i(+)} + \alpha_{2_2}^{i(+)} + \alpha_{2_3}^{i(+)} + \alpha_{2_4}^{i(+)}$ (cumulative sum of all increases) and $\alpha_{2_0}^{i(-)} + \alpha_{2_1}^{i(-)} + \alpha_{2_2}^{i(-)} + \alpha_{2_3}^{i(-)} + \alpha_{2_4}^{i(-)}$ (cumulative sum of all decreases), respectively.

Table 4.2: Model 2 Parameter Estimates (Equation (3) using PL and NB prices by market).

	Private Label				National Brand			
Variable	Mean	$t > 2$	$t < -2$	Random	Mean	$t > 2$	$t < -2$	Random
$Increase_t$	0.367	36	0	0.361	0.359	29	0	0.362
$Increase_{t-1}$	-0.188	0	6	-0.189	-0.174	1	7	-0.203
$Increase_{t-2}$	0.138	3	0	0.146	0.146	5	0	0.166

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[10] This is not unexpected. Each equation has the exact same independent variables, save the lagged dependent variable. In the case of model 3, the error correction terms are all that differ between the two equations.

$Increase_{t-3}$	0.226	9	1	0.219	0.291	13	0	0.286
$Increase_{t-4}$	-0.091	1	5	-0.097	-0.120	2	6	-0.125
$Increase_{all}$	0.453	30	0	0.439	0.501	31	0	0.485
$Decrease_{t}$	0.223	29	0	0.227	0.181	20	0	0.176
$Decrease_{t-1}$	0.294	26	0	0.292	0.349	24	0	0.356
$Decrease_{t-2}$	0.015	0	0	0.000	0.028	1	0	0.013
$Decrease_{t-3}$	-0.094	0	1	-0.097	-0.096	0	3	-0.091
$Decrease_{t-4}$	0.045	3	1	0.046	0.069	9	1	0.062
$Decrease_{all}$	0.482	35	0	0.469	0.532	37	0	0.516

Asymmetry is evident in the results, as the long-run effect of farm price decreases outweighs the long-run effect of farm price increases. The OLS R^2 ranged from 0.25 to 0.89 for this model run on private labels and from 0.19 to 0.80 for national brands. The R^2 for the Swamy method is 0.21 for private labels, and 0.12 for national brands.

In table 4.2, the effect of a contemporaneous increase in the farm price yields a change of 0.37 in the private label retail price, and a 0.36 change in the national brand retail price. This effect is positive and significant in 36 markets for private labels and 29 markets for national brands, but is never negative and significant. The long-run effect of farm price increases is about 0.45 for private labels, 0.50 for national brands.

For farm price decreases, the price transmission was slower than that of farm price increases. Looking at the short-run dynamics, we have that in the current period, a farm price decrease brings a change of 0.22 for private labels, and 0.18 for national brands, compared with 0.29 and 0.35, respectively, for farm price decreases in the previous period. The long-run effect is 0.48 for private labels and 0.53 for national brands.

For both retail prices, the effect of a decrease in farm prices has a larger magnitude than that of an increase in farm prices. However, the results still seem to be consistent (at least in the long-run problem) in that the difference between the effect for private labels and the effect for brands of increases is the same as the effect for private labels and the effect for brands of decreases (approximately a 5 cent difference in the long-run, even smaller in the short-run). Furthermore, the long-run effect is slightly greater for national brands than for private labels in all markets, and vice versa for short-run effects.

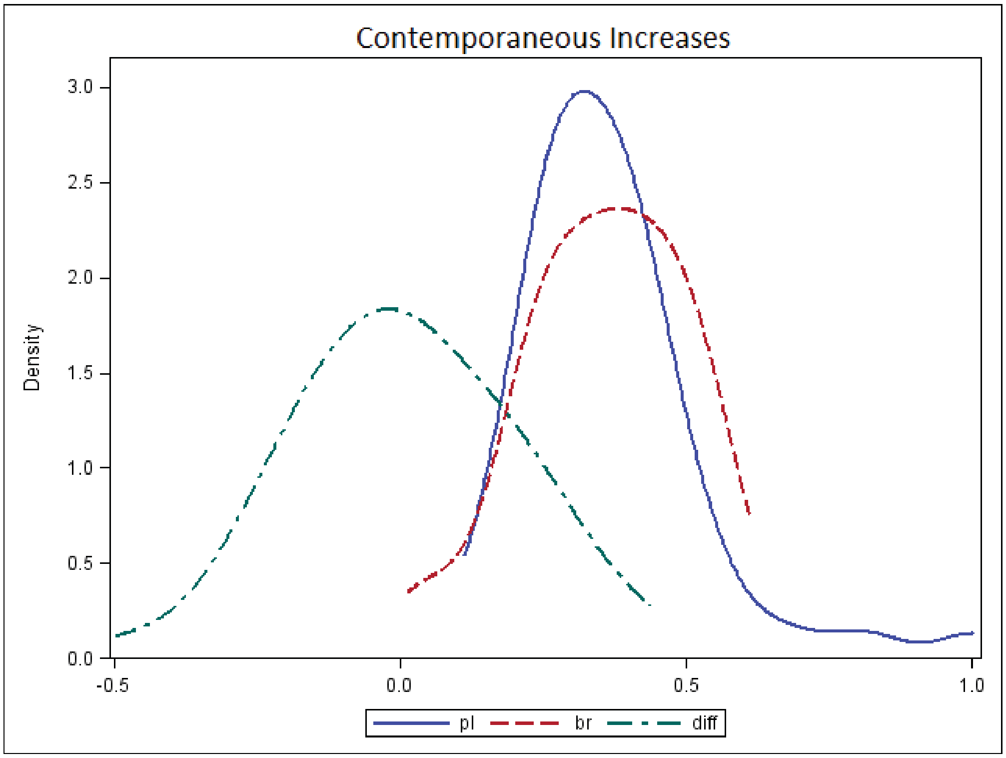

Figure 4.2. Kernel Density Plot for $\alpha_1^{Private\ Label(+)}$(“pl”), $\alpha_1^{National\ Brand(+)}$(“br”), and $\alpha_1^{Private\ Label(+)} - \alpha_1^{National\ Brand(+)}$(“diff”).

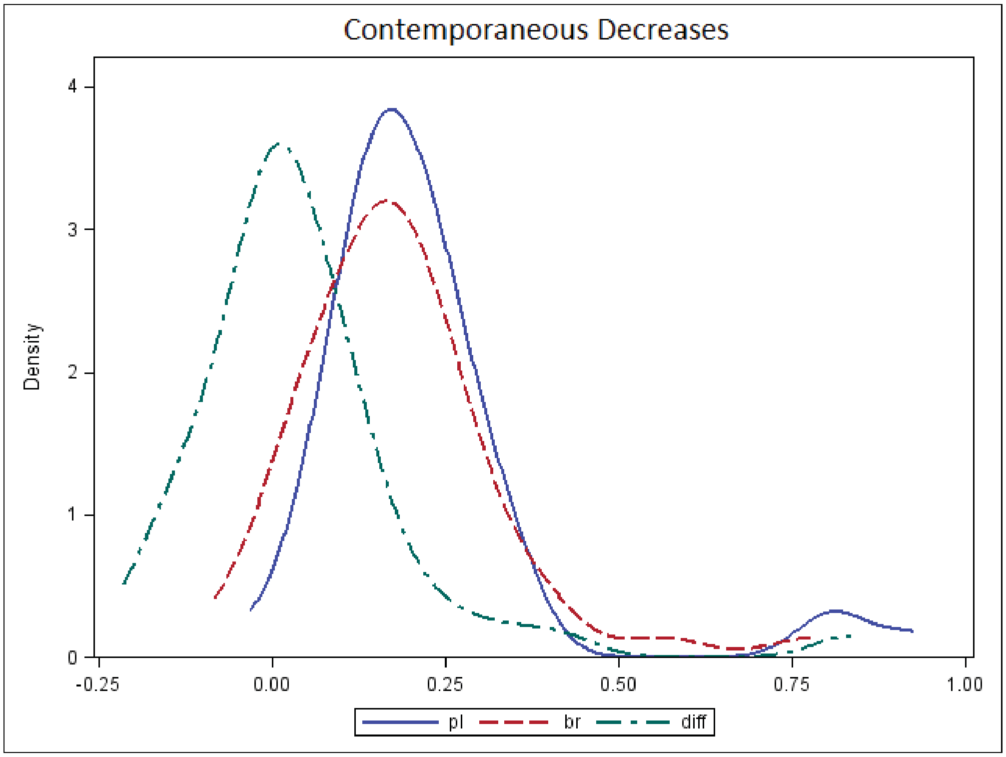

Figure 4.3. Kernel Density Plot for $\alpha_1^{Private\ Label(-)}$("pl"), $\alpha_1^{National\ Brand(-)}$("br"), and $\alpha_1^{Private\ Label(-)} - \alpha_1^{National\ Brand(-)}$("diff").

Figures 4.2 and 4.3 show the distributions of the contemporaneous increases and decreases in the farm price; again, the distribution for private labels largely overlaps that of national brands, and the distribution of their difference is centered near 0.

Estimating SUR, the R^2 ranges from 0.19 to 0.89. Chow tests indicate the responses of private labels and national brands are significantly different for 8 markets at the 10% level or better. Results of these tests can be seen in Table A4, where the null hypothesis is that all coefficients (increases and decreases paired between private labels and national brands) are equal. This tells us that, in the short-run, the responses are no different in 43 of the 51 markets. Table A6 presents the test results of the null hypothesis that, in the long-run, the responses are the same, which proves to be the case in 45 markets at 10% significance or better. After comparing overall long-run effects, we exploit the model specification which separates increases in the farm price from decreases to test whether or not long-run increases in the farm price are passed through to private label prices in the same way to national brand prices. Table A7 shows that we reject this null hypothesis in 5 of the 51 markets at the 10% level or better. Similarly for long-run decreases in the farm price, Table A8 shows that we reject the null hypothesis in 6 markets at the 10% level or better. Hence, we see very little empirical evidence that the retail prices of private labels and national brands respond to farm price shocks in a significantly different fashion – both in the long-run and the short-run. These small numbers of markets could arguably be what we would expect by pure chance.

Since this model was developed as a test for asymmetric price transmission, we apply a joint F-test to all "increase" parameters and all "decrease" parameters, pairing the appropriate time periods. We find that for 36 of the 51 markets, the effect of farm price increases on private label retail prices is significantly different than the effect of farm price decreases at the 10% level or better, and 37 markets for national brands. While we use more markets and different data (for example, we are not accounting for fat content in milk) than Capps and Sherwell (2007), our results are in line with their findings on price transmission asymmetry in fluid milk markets.

Looking back to table 4.2, the patterns of asymmetry are clear. In the current time period, the magnitude of the coefficient on a farm price increase is larger than that of a farm price decrease. This is the case for both private labels and national brands. Moving back one month to the first lag of the farm price increases, the effect is now negative, whereas the effect of a first lag on farm price decreases is still positive. What is noteworthy about this pattern is that it occurs in both cases – that of private labels and that of national brands. We also see similar patterns in market groupings across private labels and national brands for which a particular coefficient (or group of coefficients) is statistically significant. Another pattern seen in both cases is that after the first lag on farm price decreases, the significance of the effects dwindle, but for several time periods, the effects of farm price increases tend to linger.

4.3 Model 3 Results (PL vs NB)

When estimating the third model, we are essentially looking for three things: whether or not the effect for private labels is different from the effect for national brands, asymmetry in the transmission (this model was, also, developed as a test for asymmetry), and evidence of cointegration (now that error correction terms are included – segmented into negative and positive terms ECT_{neg} and ECT_{pos}, respectively). The OLS R^2 for this model ranged from 0.26 to 0.91 for private labels and from 0.21 to 0.59 for national brands. The Swamy R^2 is 0.21 for private labels, and 0.14 for national brands.

Table 4.3: Model 3 Parameter Estimates (Equation (4) using PL and NB Prices by Market).

	Private Label				National Brand			
Variable	Mean	$t > 2$	$t < -2$	Random	Mean	$t > 2$	$t < -2$	Random
$Increase_t$	0.409	43	0	0.400	0.392	39	0	0.399
$Increase_{t-1}$	-0.273	0	14	-0.310	-0.299	0	19	-0.266
$Increase_{t-2}$	0.049	3	0	0.057	0.034	2	0	0.062
$Increase_{t-3}$	0.174	7	1	0.252	0.246	11	0	0.175
$Increase_{t-4}$	-0.078	1	5	-0.135	-0.130	1	6	-0.081
$Increase_{all}$	0.282	23	0	0.264	0.242	14	0	0.290
$Decrease_t$	0.193	21	0	0.147	0.152	16	0	0.197
$Decrease_{t-1}$	0.222	18	0	0.284	0.265	21	0	0.228
$Decrease_{t-2}$	-0.013	0	0	-0.017	-0.009	0	0	-0.020
$Decrease_{t-3}$	-0.091	0	3	-0.112	-0.120	0	3	-0.092
$Decrease_{t-4}$	0.009	0	2	0.037	0.037	3	0	0.007
$Decrease_{all}$	0.389	25	0	0.340	0.324	19	0	0.320
ECT_{neg}	-0.211	0	26	-0.255	-0.273	0	32	-0.184
ECT_{pos}	-0.162	0	18	-0.135	-0.148	0	20	-0.145

Estimating OLS across the 51 markets, we observe the effect of a contemporaneous farm price increase to be 0.40 for private labels (positive and significant in 43 out of 51 markets), 0.40 for national brands (positive and significant in 39 out of 51 markets). The long-run increases also have a similar pattern: 0.26 for private labels, and 0.29 for national brands.

When we look at table 4.3 with respect to decreasing farm prices, the point estimate on the current farm price decrease is 0.15 for private label, 0.20 for national brand (positive and significant in 21 and 16 out of 51 markets for private labels and national brands, respectively). The point estimate on the first lag of the farm price decreases is 0.28 for private label, 0.23 for national brand (positive and significant in 18, 21 out of 51 markets for private labels and national brands, respectively). The long-run decreases for private labels is 0.34 for private labels and 0.32 for national brands.

Asymmetry seems to be evident in the results seen in table 4.3. When performing joint F-tests on all increases and decreases (this time, including the segmented error correction terms), we find asymmetry[11] in 41 out of 51 markets for private labels, and 43 out of 51 markets for national brands. In fact, patterns similar to those in the second model appear in this model also, as seen in table 4.3.

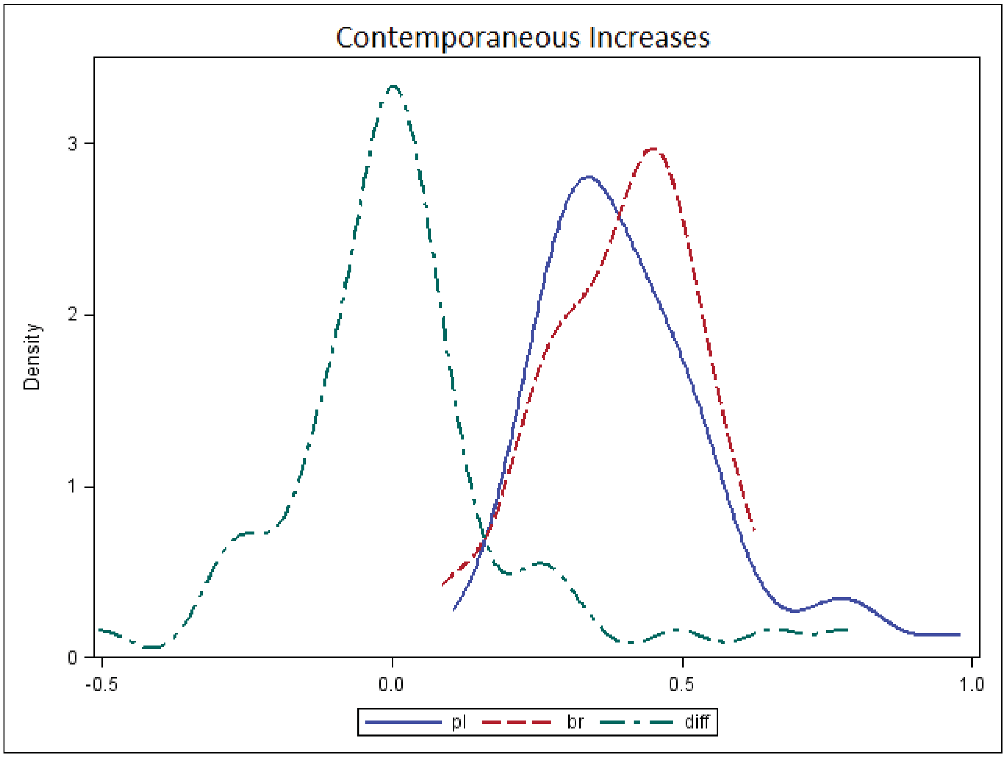

Figure 4.4: Kernel Density Plot for $\gamma_1^{Private\ Label(+)}$("pl"), $\gamma_1^{National\ Brand(+)}$("br"), and $\gamma_1^{Private\ Label(+)} - \gamma_1^{National\ Brand(+)}$("diff").

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[11] The general term, "asymmetry", implies that we found the farm price increases to be statistically significantly different from the farm price decreases at the 10% confidence level.

Figures 4.4 and 4.5 show the kernel densities for the short-run effects of farm price shocks. As in model 2, the difference of the effects is centered close to 0. The long-run effects (whose differences are also centered near 0) are in the appendix in figures B4 and B5.

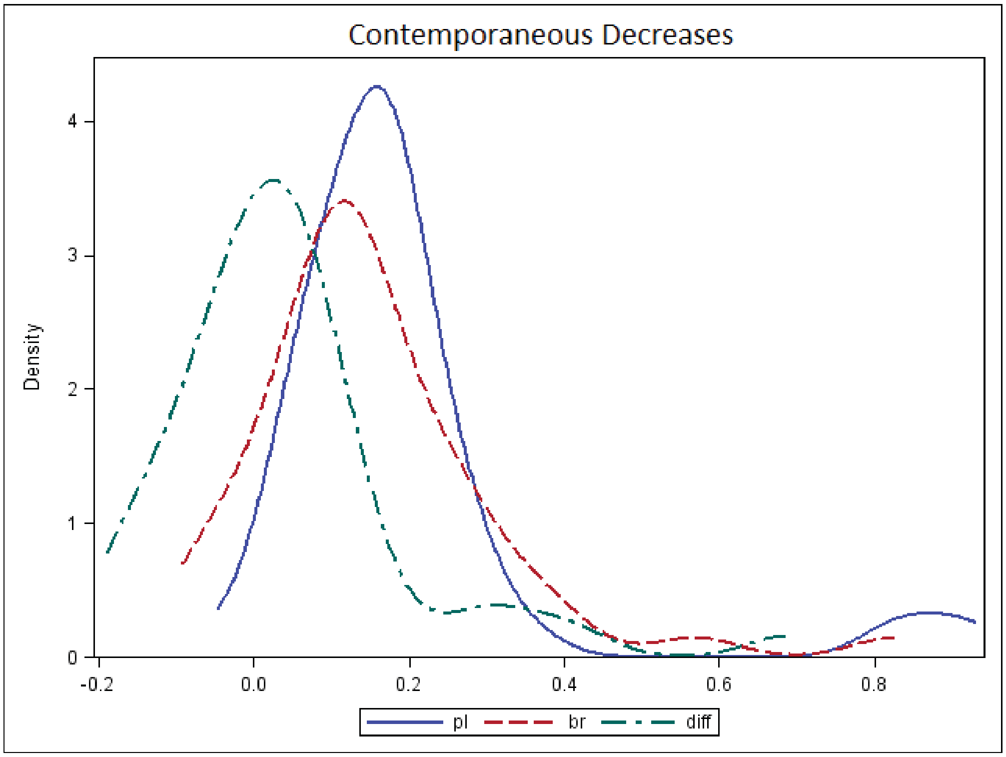

Figure 4.5: Kernel Density Plot for $\gamma_1^{Private\ Label(+)}$("pl"), $\gamma_1^{National\ Brand(+)}$("br"), and $\gamma_1^{Private\ Label(+)} - \gamma_1^{National\ Brand(+)}$("diff").

The segmented error correction terms (in Table 4.3, ECT_{neg} and ECT_{pos} are the negative and positive error correction segmentations, respectively) show clear signs of cointegration between farm and retail prices. They are significant in over half of the sample of markets, and negative in all 51. This indicates that the retail prices are, in fact, below equilibrium and/or the farm prices are above equilibrium[12] in the short-run.

When we estimate the model using SUR, with R^2 ranging from 0.21 to 0.92, the coefficients differed, again, very little from the OLS estimates. Once estimating SUR, we turn to Chow tests to test the responses of private labels and national brands. As seen in Table A5 Chow tests indicated that the contemporaneous effect is significantly different for 14 at the 10% level or better. Table A6 presents Chow test results where the null hypothesis is that, in the long-run, the overall effect of farm price shocks for private labels is significantly different from that of national brands. We reject this hypothesis in only 11 markets at the 10% level or better.

Again, taking advantage of having increases and decreases accounted for separately, we look to Tables A7 and A8 show Chow test statistics and the corresponding p-values for testing the null hypothesis that the long-run increases and long-run decreases, respectively, are statistically different between private labels and national brands. As seen, we reject the null hypothesis in 8 markets in the farm price increases case and 6 markets in the farm price decreases case at the 10% level or better. This lends further evidence that, in the long run also, the effects of farm price shocks are equivalent for private labels and national brands in a large majority of US cities.

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[12] The general term “equilibrium” refers to the long-run relationship between the farm and retail prices, if they are, in fact, cointegrated.

4.4 Model 1 Results (PL vs PL)

Using the same model specification and assumptions about the data, we apply the model on two new price series – private label retail prices of retailers for whom private labels are a relatively high share of sales (on average, about a 56:1 ratio of monthly private label sales to monthly branded sales), and private label retail prices of retailers for whom private labels are a relatively low share of sales (on average, about a 6:1 ratio of monthly private label sales to monthly branded sales). Rephrased, we examine the price-setting behavior of retailers who feature national brands and those who emphasize more on private labels.

Table 4.4: Model 1 Parameter Estimates (Equation (2) using PL Prices by Retailer).

	Higher Share PL			Lower Share PL		
Variable	Estimate	$t > 2$	$t < -2$	Estimate	$t > 2$	$t < -2$
$Retail_{t-1}$	0.282	17	0	0.208	7	0
$Farm_t$	0.902	119	0	0.925	120	0
$Farm_{t-1}$	-0.550	0	94	-0.503	0	88
$Farm_{t-2}$	-0.171	0	7	-0.172	0	13
$Farm_{t-3}$	-0.342	0	54	-0.368	0	46
$Farm_{t-4}$	-0.091	0	1	-0.096	0	2
$Farm_{t-5}$	-0.098	1	1	-0.108	0	2
$Farm_{all}$	-0.488	8	2	-0.407	3	5

In table 4.4, we see the results are very close (on average) between retailers who sell more national brand milk alongside private label milk and those that sell less branded milk alongside private label milk. The differences between the responses in the retail prices of the two retailer types in both the long-run and short-run are the same as the differences seen in the PL v NB case – very similar magnitudes and patterns in the coefficients and groupings in retailers for which the coefficients are significant.

According to the model, a one dollar increase in the farm price is estimated to cause a 90 cent increase in the private label price of milk sold in stores that sell relatively more national brands versus a 92 cent increase in the private label price of milk sold in stores that sell relatively fewer brands: This contemporaneous effect is positive and statistically significant at the 5% level for every retailer but one for the high-share retailers and for all 120 low-share retailers (the long-run effect is hardly ever significant for both retailer types). Clearly, this effect differs very little between the two types of retailers.

4.5 Model 2 Results (PL vs PL)

Recall that the model takes the form

$$(3) \qquad \Delta^{*} P_t^i = \alpha_0^i t + \sum_{m=0}^{4} \alpha_m^{i(+)} \Delta^{(+)} P_{t-m}^{farm} + \sum_{n=0}^{4} \alpha_n^{i(-)} \Delta^{(-)} P_{t-n}^{farm} + \nu_t^i$$

where

$$i \in \{Private\ Label, National\ Brand\},$$

$$\Delta^{(+)} P_t^{farm} = \begin{cases} P_t^{farm} - P_{t-1}^{farm}, if\ P_t^{farm} > P_{t-1}^{farm} \\ 0, otherwise \end{cases},$$

$$\Delta^{(-)} P_t^{farm} = \begin{cases} P_t^{farm} - P_{t-1}^{farm}, if\ P_t^{farm} < P_{t-1}^{farm} \\ 0, otherwise \end{cases}.$$

Note that, in this instance, the index *i* takes on the values of retailers who promote national brands and those who don't. That is, we are considering two types of retailers: those who sell relatively more national brands and those who sell relatively fewer national brands. As stated in the model 1 results, we may think of these retailers as having relatively low shares of private label sales, and relatively high shares of private label sales, respectively.

Table 4.5: Model 2 Parameter Estimates (Equation (3) using PL Prices by Retailer).

	Higher Share PL			Lower Share PL		
Variable	Estimate	$t > 2$	$t < -2$	Estimate	$t > 2$	$t < -2$
$Increase_t$	0.375	60	1	0.397	67	1
$Increase_{t-1}$	-0.216	2	24	-0.172	2	19
$Increase_{t-2}$	0.192	10	2	0.113	8	1
$Increase_{t-3}$	0.190	11	2	0.282	18	0
$Increase_{t-4}$	-0.105	1	10	-0.107	0	12
$Increase_{all}$	0.436	51	0	0.513	53	0
$Decrease_t$	0.243	50	1	0.223	42	0
$Decrease_{t-1}$	0.295	39	1	0.321	41	1
$Decrease_{t-2}$	-0.014	4	3	0.053	3	2
$Decrease_{t-3}$	-0.088	2	9	-0.145	1	10
$Decrease_{t-4}$	0.028	8	6	0.095	17	3
$Decrease_{all}$	0.463	55	0	0.547	57	0

When we apply this model to the firm-level data, we get the output observed in table 4.5. The parameters on current farm price increases are similar for the two types of retailers – 0.37 for high-share retailers and 0.40 for low-share retailers. In the long-run, the effects of rising farm prices are 0.44 and 0.51, respectively. In both the short-run and long-run problems, we again see a pattern that we would expect to remain consistent with no strategic pricing against national brands via private labels, in terms of positive farm price shocks.

Looking to falling farm prices, we see a pattern very similar to that of private label and national brand prices – between 39 and 50 markets of positive, significant effects for the current and 1-month lagged farm price decreases (0.24 & 0.29, respectively, for high-share retailers, and 0.22 & 0.32, respectively, for low-share retailers). In the long-run, farm price decreases give us changes of 0.46 and 0.55 for high-share and low-share retailers, respectively. Just as seen above for farm price increases, negative shocks to the farm price pass through to the two types of retailers in a very similar fashion, both in the short-run and in the long-run.

Applying this model, it appears that in both the short-run and long-run problem, increases in the farm price are passed through to private label prices of one type of retailer very much like they are to the other type of retailer. The same holds with decreases in the farm price – the price transmission patterns are very similar. This shows little to no evidence of strategic pricing on the part of retailers, which is consistent with the results previously presented from comparing price transmissions to private label and national brand retail prices.

4.6 Model 3 Results (PL vs PL)

Finally, table 4.6 summarizes the estimation of model 3 for private labels between the two groups of retailers based on private labels as a relative share of sales. Similarly to the results found in table 4.3, there is clear evidence of cointegration between the retail prices (both private label in this instance) and the farm price for the market order in which those retailers operate.

Table 4.6. Model 3 Parameter Estimates (Equation (4) using PL Prices by Retailer).

	Higher Share PL			Lower Share PL		
Variable	Estimate	$t > 2$	$t < -2$	Estimate	$t > 2$	$t < -2$
$Increase_t$	0.447	78	0	0.473	80	0
$Increase_{t-1}$	0.447	1	43	-0.328	2	37
$Increase_{t-2}$	-0.370	3	1	-0.020	1	3
$Increase_{t-3}$	0.052	9	3	0.211	16	0
$Increase_{t-4}$	0.144	0	8	-0.115	0	10
$Increase_{all}$	0.167	36	0	0.221	26	0
$Decrease_t$	0.197	37	1	0.178	28	0
$Decrease_{t-1}$	0.188	29	1	0.214	32	2
$Decrease_{t-2}$	-0.048	3	4	-0.001	3	1
$Decrease_{t-3}$	-0.093	2	6	-0.149	0	12
$Decrease_{t-4}$	0.003	3	4	0.043	3	3
$Decrease_{all}$	0.246	41	0	0.284	31	0
ECT_{neg}	-0.375	0	82	-0.352	0	80
ECT_{pos}	-0.276	1	74	-0.278	0	71

The effect of an immediate unit increase in the farm price is estimated to be 0.45 for retailers with lower branded sales (significant for 80 out of 120 of this type of retailer) and 0.47 for retailers with higher branded sales (significant for 78 out of 120 of these retailers). In the long-run, the point estimates for high and low-share retailers are 0.17 and 0.22, respectively (significant for 36 and 26 retailers, respectively). It appears that in both the short-run problem and the long-run problem, the retailers who sell relatively more branded milk tend to pass-through more of farm price increases to the price of their private label milk than do retailers who sell relatively less branded milk. However, it is the case that the effects differ by only about 0.05 in this instance, which indicates that, while one retailer type demonstrates a larger price transmission, the effects differ by very little.

The coefficient on an immediate unit decrease in the farm price is estimated at 0.20 for high-share retailers (positive and significant for 37 out of 120 retailers) and 0.18 for low-share retailers (positive and significant for 28 out of 120 retailers). For a one month lag of a unit decrease in the farm price, the effect for high-share retailers is 0.19 (positive, significant for 29 retailers) and 0.21 for low-share retailers (positive, significant for 32 retailers). The long-run effect is estimated to be 0.25 for high-share retailers and 0.28 for low-share retailers. The only consistent pattern we observe here is that the effects are, on average, very close together.

Evidently, in both the short-run and the long-run, two different retailer types who clearly face different relationships with branded products tend to respond in very similar fashions to equivalent changes in each of the wholesale prices of their respective private label products. This, also, is consistent with the previous lack of evidence of strategic pricing by retailers against national brand products via private labels.

CHAPTER 5. CONCLUSION

5.1 Private Label Retail Prices vs. National Brand Retail Prices

When estimating the price transmission parameters for private labels and national brands for every market, we see the same pattern across all three model specifications: the effect is, on average, the same for both labels of milk, private and branded. When calculating the difference of the pass-through of farm prices to private label retail prices and the pass-through to national brands, the distribution of the difference across the 51 markets is centered directly at 0. Furthermore, when we investigate more formally using Chow tests, we saw the pass-through as statistically different for less than 15 of the 51 markets in the Nielsen data. While these markets may provide more insight into the relationship between private labels and national brands, they are, at least, in the minority.

While there was evidence of cointegration between the farm and retail prices, and clear signs of asymmetry in the segmented error correction terms, the same pattern of asymmetry held for both private labels and national brands (negative speed of adjustment outweighed the positive, ie, the negative error correction segments had larger coefficients than the positive error correction segments). This indicates that, in a large number of markets, the farm and retail prices are not in the long-run equilibrium that the two share.

As aforementioned, the results are robust to functional form specification. In every model, the farm price was passed through in the same way, regardless of the model we chose. Given that our data generating processes define our model specifications, our results are also robust to any assumptions we can make about the behavior of the data.

Our robust findings indicate the same conclusion in all three instances – we find little empirical evidence that retailers use private labels as a tool to strategically manipulate the prices of national brand products. We see the responses of private labels to shocks in the farm price are, at least on average, equivalent to those of national brand retail prices. If retailers were acting in a fashion similar to that laid out in the competitive view or the market segmentation view, it is reasonable to expect the responses (that is, the price changes made by the retailers) to be noticeably different. Empirically, that is not the case.

However, one should note that these results, while robust, are not infallible. In all three models, there are markets where there are significantly different responses from private labels and national brands. Indeed, as many as 14 markets – or 27% of our sample of 51 markets – bear evidence of retailers setting the two retail prices in a dissimilar fashion from one another, as was the case for the third model when comparing the two responses. Perhaps it would be informative to further analyze these specific markets in the future.

5.3 Private Labels from Different Types of Retailers

When we re-estimated all 3 models using the private label prices of two groups of retailers, we expected that if any strategy across labels was, in fact, taking place in stores in our data, then we would see evidence of differences across the two groups. The exact nature of is not important. Whether changes in private label prices caused the relative national brand price to go up or down is of no consequence; it is logical to anticipate retailers who sell more branded milk in their stores to adjust their prices differently than retailers who sell less. Assuming strategic pricing, we might expect changes in the farm price to be passed through to private label retail prices quite differently by the two types of firms.

We found no empirical evidence of this. We find that, robust to model specification, the pass-through of farm prices to private labels with more competition from brands and private labels with less competition from brands appear to be very close to one another. On average, the farm price is passed through the same to both of these private label prices. This leads us to believe that retailers who sell more national brands respond to increased costs the same way that retailers who sell fewer national brands do. This is, at the very least, inconsistent with any theory that suggests that private labels strategically compete with national brands.

CHAPTER 6. IMPLICATIONS FOR FUTURE RESEARCH

Given that we find very little empirical evidence consistent with strategic pricing by firms between private labels and national brands (such as the strategies presented in the two theories given at the outset of this paper), it would certainly appear that, at least in the case of fluid milk, (i) stores do not appear to use private labels as a strategic weapon on the market level, (ii) retailers who deal primarily with private label goods do not respond to farm price shocks any differently than retailers who promote both private labels and national brands. In other words, private labels and national brands do not seem to compete strategically– they are two versions of the same product.

The purpose of retailers carrying private labels could simply be because they are profitable. As mentioned before, retailers can avoid double marginalization with private labels and earn a wider margin on them. As a result, retailers have incentive not only to carry private labels but to feature them prominently, which could arguably be the driving reason behind the existence of private labels, rather than use as an instrument of competition. Private labels certainly dominate the fluid milk market, as stated at the outset of this paper, which is consistent with this argument.

These implications would suggest that either we lose the information needed to evaluate the competition when we average prices at the market level (and thus, “mask” the true underlying dynamics at play), and therefore we need firm-level data that has complete observations for the brands sold within each individual store to capture this relationship, or perhaps private labels do not, in fact, compete with national brands but across retailers.

In addition to these observations, another interesting factor that could help promote future study is container size. We used milk data sold only in gallons, but perhaps the competition between private labels and national brands comes into play for smaller container sizes which have a higher price per unit.

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APPENDICES

Appendix A: Tables

Table A1. Summary Statistics: Prices ($/oz) of 2% Milk in Gallons for Private Labels and National Brands in Chicago and Boston, 2004-2010.

Chicago

Brand	Mean	St. Dev.	Min	Max
PL 1	0.021	0.002	0.016	0.025
NB A sold in Store 1	0.022	0.004	0.016	0.030
NB B sold in Store 1	0.029	0.002	0.024	0.031
PL 2	0.018	0.003	0.013	0.024
NB B sold in Store 2	0.029	0.002	0.024	0.031
PL 3	0.018	0.004	0.008	0.031
NB C sold in Store 3	0.018	0.002	0.015	0.024
PL 4	0.022	0.003	0.016	0.028
PL 5	0.017	0.002	0.012	0.022
PL 6	0.020	0.005	0.013	0.028
NB D sold in Store 6	0.022	0.006	0.015	0.031

Boston

PL 7	0.020	0.002	0.009	0.029
NB E sold in Store 7	0.023	0.003	0.020	0.030
NB F sold in Store 7	0.024	0.003	0.020	0.031
PL 8	0.025	0.004	0.017	0.047
NB E sold in Store 8	0.029	0.004	0.016	0.038
NB F sold in Store 8	0.031	0.004	0.021	0.055
PL 9	0.024	0.004	0.018	0.070
NB E sold in Store 9	0.028	0.004	0.020	0.051
NB F sold in Store 9	0.031	0.005	0.022	0.059
PL 10	0.023	0.005	0.018	0.078
NB E sold in Store 10	0.027	0.004	0.021	0.037

Note: PL = Private Label, NB = National Brand; Store numbers correspond to PL numbers (source: author’s calculations from Nielsen Homescan Data).

Table A2. Market Level Summary Statistics for Private Label Retail Prices ($/FlOz) and National Brand Retail Prices ($/FlOz) aggregated across Retailers, 2004-2010.

City	**Mean - Private Label**	**StDev - Private Label**	**Max - Private Label**	**Min - Private Label**	**Mean - National Brand**	**StDev - National Brand**	**Max - National Brand**	**Min - National Brand**
BOSTON	0.0221	0.0021	0.0264	0.0190	0.0249	0.0030	0.0322	0.0213
CHICAGO	0.0186	0.0020	0.0230	0.0156	0.0204	0.0023	0.0247	0.0163
HOUSTON	0.0228	0.0029	0.0281	0.0165	0.0257	0.0023	0.0313	0.0218
INDIANAPOLIS	0.0187	0.0025	0.0239	0.0152	0.0216	0.0025	0.0276	0.0171
JACKSONVILLE	0.0264	0.0031	0.0332	0.0214	0.0238	0.0030	0.0304	0.0183
KANSAS CITY	0.0228	0.0025	0.0275	0.0190	0.0238	0.0030	0.0296	0.0197
LOS ANGELES	0.0208	0.0028	0.0272	0.0168	0.0229	0.0027	0.0301	0.0184
SURBURBAN NY	0.0244	0.0024	0.0299	0.0205	0.0249	0.0029	0.0314	0.0212
URBAN NY	0.0247	0.0027	0.0309	0.0197	0.0260	0.0027	0.0319	0.0218
EXURBAN NY	0.0242	0.0023	0.0293	0.0201	0.0250	0.0025	0.0307	0.0210
ORLANDO	0.0256	0.0030	0.0326	0.0215	0.0238	0.0030	0.0307	0.0192
SAN FRANCISCO	0.0220	0.0029	0.0284	0.0184	0.0288	0.0033	0.0364	0.0232
SEATTLE	0.0198	0.0022	0.0245	0.0166	0.0204	0.0025	0.0260	0.0168
ATLANTA	0.0230	0.0041	0.0307	0.0161	0.0280	0.0033	0.0376	0.0213
CINCINNATI	0.0187	0.0023	0.0233	0.0141	0.0220	0.0026	0.0287	0.0187
CLEVELAND	0.0209	0.0028	0.0268	0.0161	0.0217	0.0025	0.0267	0.0184
DALLAS	0.0216	0.0042	0.0287	0.0116	0.0264	0.0030	0.0334	0.0207
DENVER	0.0212	0.0034	0.0264	0.0129	0.0203	0.0030	0.0249	0.0141
DETROIT	0.0187	0.0029	0.0244	0.0129	0.0208	0.0022	0.0252	0.0177
MIAMI	0.0258	0.0029	0.0324	0.0221	0.0242	0.0027	0.0304	0.0212
MILWAUKEE	0.0200	0.0020	0.0238	0.0164	0.0220	0.0019	0.0265	0.0187
MINNEAPOLIS	0.0202	0.0024	0.0248	0.0162	0.0243	0.0021	0.0288	0.0216
NASHVILLE	0.0228	0.0027	0.0287	0.0184	0.0250	0.0026	0.0305	0.0207
PHILADELPHIA	0.0257	0.0024	0.0306	0.0222	0.0255	0.0024	0.0307	0.0217
PITTSBURGH	0.0231	0.0023	0.0284	0.0194	0.0248	0.0025	0.0297	0.0208
PORTLAND, OR	0.0192	0.0022	0.0231	0.0163	0.0214	0.0027	0.0280	0.0179
ST. LOUIS	0.0214	0.0025	0.0267	0.0174	0.0227	0.0026	0.0278	0.0189
TAMPA	0.0257	0.0028	0.0318	0.0214	0.0242	0.0027	0.0300	0.0210
BALTIMORE	0.0248	0.0022	0.0294	0.0216	0.0232	0.0027	0.0300	0.0191
BIRMINGHAM	0.0249	0.0029	0.0309	0.0203	0.0266	0.0029	0.0329	0.0214
BUFFALO-ROCHESTER	0.0172	0.0029	0.0224	0.0133	0.0200	0.0028	0.0266	0.0169
HARTFORD-NEW HAVEN	0.0238	0.0021	0.0286	0.0203	0.0247	0.0029	0.0319	0.0199
LITTLE ROCK	0.0241	0.0029	0.0301	0.0203	0.0257	0.0028	0.0311	0.0221
MEMPHIS	0.0234	0.0030	0.0300	0.0203	0.0243	0.0027	0.0301	0.0204

NEW ORLEANS-MOBILE	0.0278	0.0026	0.0332	0.0230	0.0289	0.0030	0.0353	0.0231
OKLAHOMA CITY-TULSA	0.0239	0.0027	0.0297	0.0200	0.0245	0.0026	0.0302	0.0206
PHOENIX	0.0183	0.0026	0.0237	0.0142	0.0221	0.0025	0.0281	0.0188
RALEIGH-DURHAM	0.0262	0.0026	0.0302	0.0207	0.0241	0.0026	0.0293	0.0189
SALT LAKE CITY	0.0179	0.0023	0.0229	0.0151	0.0189	0.0025	0.0242	0.0151
COLUMBUS	0.0186	0.0023	0.0244	0.0149	0.0212	0.0024	0.0265	0.0179
WASHINGTON, DC	0.0245	0.0022	0.0293	0.0215	0.0239	0.0024	0.0296	0.0199
ALBANY	0.0223	0.0029	0.0293	0.0186	0.0235	0.0024	0.0289	0.0199
CHARLOTTE	0.0254	0.0027	0.0297	0.0199	0.0244	0.0025	0.0299	0.0206
DES MOINES	0.0208	0.0029	0.0269	0.0162	0.0217	0.0031	0.0277	0.0168
GRAND RAPIDS	0.0189	0.0028	0.0246	0.0153	0.0215	0.0024	0.0264	0.0182
LOUISVILLE	0.0197	0.0028	0.0257	0.0153	0.0242	0.0030	0.0309	0.0190
OMAHA	0.0222	0.0025	0.0274	0.0175	0.0224	0.0026	0.0277	0.0183
RICHMOND	0.0256	0.0031	0.0318	0.0194	0.0236	0.0025	0.0295	0.0192
SACRAMENTO	0.0212	0.0028	0.0276	0.0174	0.0251	0.0029	0.0312	0.0201
SAN ANTONIO	0.0247	0.0020	0.0307	0.0216	0.0249	0.0025	0.0302	0.0214
SYRACUSE	0.0185	0.0026	0.0242	0.0157	0.0211	0.0027	0.0273	0.0167

Source: author’s calculations from Nielsen Homescan Data.

Table A3. Model 1 Chow Test comparing Net Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 1 – Chow Test			$H_0: All\ coefficients\ equal$	
Obs	MarketID	F-Value	Prob>F	City
1	50	3.71	0.0010	SACRAMENTO
2	51	2.79	0.0094	SAN ANTONIO
3	38	2.59	0.0152	PHOENIX
4	35	2.22	0.0362	MEMPHIS
5	5	2.13	0.0436	JACKSONVILLE
6	26	2.07	0.0501	PORTLAND, OR
7	17	2.03	0.0547	DALLAS
8	2	1.80	0.0911	CHICAGO
9	8	1.75	0.1017	SURBURBAN NY
10	49	1.69	0.1170	RICHMOND
11	44	1.60	0.1391	CHARLOTTE
12	21	1.55	0.1550	MILWAUKEE
13	7	1.51	0.1691	LOS ANGELES
14	24	1.41	0.2044	PHILADELPHIA
15	22	1.41	0.2049	MINNEAPOLIS
16	30	1.38	0.2192	BALTIMORE
17	42	1.32	0.2461	WASHINGTON, DC
18	34	1.18	0.3167	LITTLE ROCK
19	9	1.12	0.3510	URBAN NY
20	12	1.10	0.3663	SAN FRANCISCO
21	33	1.06	0.3957	HARTFORD-NEW HAVEN
22	46	0.97	0.4543	GRAND RAPIDS
23	39	0.97	0.4544	RALEIGH-DURHAM
24	48	0.92	0.4895	OMAHA
25	32	0.92	0.4909	BUFFALO-ROCHESTER
26	1	0.90	0.5082	BOSTON
27	29	0.83	0.5621	TAMPA
28	45	0.82	0.5720	DES MOINES
29	10	0.80	0.5857	EXURBAN NY
30	6	0.77	0.6095	KANSAS CITY
31	18	0.76	0.6176	DENVER
32	41	0.75	0.6259	COLUMBUS
33	43	0.74	0.6352	ALBANY
34	37	0.73	0.6503	OKLAHOMA CITY-TULSA
35	16	0.72	0.6548	CLEVELAND
36	15	0.72	0.6585	CINCINNATI

37	14	0.69	0.6824	ATLANTA
38	3	0.65	0.7121	HOUSTON
39	11	0.63	0.7289	ORLANDO
40	28	0.60	0.7537	ST. LOUIS
41	20	0.55	0.7942	MIAMI
42	40	0.44	0.8789	SALT LAKE CITY
43	36	0.40	0.8993	NEW ORLEANS-MOBILE
44	25	0.39	0.9062	PITTSBURGH
45	13	0.38	0.9110	SEATTLE
46	52	0.38	0.9135	SYRACUSE
47	31	0.38	0.9154	BIRMINGHAM
48	19	0.34	0.9322	DETROIT
49	23	0.26	0.9692	NASHVILLE
50	4	0.25	0.9718	INDIANAPOLIS
51	47	0.18	0.9898	LOUISVILLE

Table A4. Model 2 Chow Test comparing Net Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 2 – Chow Test		$H_0: All\ coefficients\ equal$		
Obs	MarketID	F-Value	Prob>F	City
1	7	2.87	0.0028	LOS ANGELES
2	24	2.59	0.0067	PHILADELPHIA
3	39	2.17	0.0235	RALEIGH-DURHAM
4	11	2.10	0.0287	ORLANDO
5	17	1.98	0.0407	DALLAS
6	22	1.89	0.0514	MINNEAPOLIS
7	2	1.83	0.0607	CHICAGO
8	38	1.75	0.0751	PHOENIX
9	45	1.59	0.1159	DES MOINES
10	44	1.57	0.1220	CHARLOTTE
11	14	1.56	0.1260	ATLANTA
12	35	1.46	0.1602	MEMPHIS
13	12	1.43	0.1753	SAN FRANCISCO
14	30	1.38	0.1949	BALTIMORE
15	50	1.35	0.2111	SACRAMENTO
16	29	1.35	0.2129	TAMPA
17	46	1.23	0.2793	GRAND RAPIDS
18	13	1.22	0.2810	SEATTLE
19	8	1.18	0.3091	SURBURBAN NY
20	48	1.11	0.3599	OMAHA
21	32	1.11	0.3628	BUFFALO-ROCHESTER
22	34	1.07	0.3861	LITTLE ROCK
23	5	1.07	0.3905	JACKSONVILLE
24	28	1.06	0.3963	ST. LOUIS
25	26	1.00	0.4484	PORTLAND, OR
26	43	0.99	0.4549	ALBANY
27	42	0.99	0.4555	WASHINGTON, DC
28	40	0.98	0.4662	SALT LAKE CITY
29	6	0.97	0.4751	KANSAS CITY
30	16	0.93	0.5080	CLEVELAND
31	49	0.90	0.5316	RICHMOND
32	37	0.87	0.5634	OKLAHOMA CITY-TULSA
33	33	0.86	0.5747	HARTFORD-NEW HAVEN
34	52	0.86	0.5753	SYRACUSE
35	20	0.76	0.6630	MIAMI
36	51	0.70	0.7210	SAN ANTONIO

37	18	0.67	0.7528	DENVER
38	1	0.66	0.7617	BOSTON
39	9	0.62	0.7972	URBAN NY
40	15	0.59	0.8191	CINCINNATI
41	19	0.58	0.8257	DETROIT
42	3	0.55	0.8530	HOUSTON
43	31	0.54	0.8607	BIRMINGHAM
44	41	0.54	0.8624	COLUMBUS
45	23	0.49	0.8929	NASHVILLE
46	25	0.40	0.9452	PITTSBURGH
47	4	0.39	0.9500	INDIANAPOLIS
48	10	0.36	0.9612	EXURBAN NY
49	21	0.32	0.9758	MILWAUKEE
50	36	0.31	0.9778	NEW ORLEANS-MOBILE
51	47	0.27	0.9862	LOUISVILLE

Table A5. Model 3 Chow Test comparing Net Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 3 – Chow Test			$H_0: All\ coefficients\ equal$	
Obs	MarketID	F-Value	Prob>F	City
1	7	5.31	0.0001	LOS ANGELES
2	46	3.48	0.0002	GRAND RAPIDS
3	50	2.50	0.0056	SACRAMENTO
4	49	2.41	0.0074	RICHMOND
5	25	2.39	0.0081	PITTSBURGH
6	17	2.25	0.0127	DALLAS
7	9	2.23	0.0136	URBAN NY
8	5	2.08	0.0221	JACKSONVILLE
9	38	2.05	0.0249	PHOENIX
10	14	1.85	0.0464	ATLANTA
11	8	1.83	0.0498	SURBURBAN NY
12	42	1.79	0.0554	WASHINGTON, DC
13	2	1.71	0.0709	CHICAGO
14	20	1.69	0.0756	MIAMI
15	33	1.57	0.1084	HARTFORD-NEW HAVEN
16	35	1.45	0.1513	MEMPHIS
17	41	1.39	0.1771	COLUMBUS
18	16	1.35	0.1985	CLEVELAND
19	44	1.35	0.2005	CHARLOTTE
20	39	1.33	0.2074	RALEIGH-DURHAM
21	48	1.33	0.2097	OMAHA
22	24	1.28	0.2351	PHILADELPHIA
23	23	1.27	0.2416	NASHVILLE
24	19	1.26	0.2491	DETROIT
25	1	1.22	0.2777	BOSTON
26	32	1.20	0.2903	BUFFALO-ROCHESTER
27	22	1.19	0.2950	MINNEAPOLIS
28	13	1.16	0.3151	SEATTLE
29	28	1.16	0.3200	ST. LOUIS
30	45	1.16	0.3207	DES MOINES
31	26	1.08	0.3811	PORTLAND, OR
32	34	1.07	0.3935	LITTLE ROCK
33	30	1.05	0.4043	BALTIMORE
34	3	1.00	0.4527	HOUSTON
35	40	0.99	0.4588	SALT LAKE CITY
36	4	0.98	0.4740	INDIANAPOLIS

37	51	0.92	0.5251	SAN ANTONIO
38	12	0.87	0.5808	SAN FRANCISCO
39	15	0.86	0.5873	CINCINNATI
40	52	0.86	0.5937	SYRACUSE
41	18	0.84	0.6103	DENVER
42	31	0.81	0.6445	BIRMINGHAM
43	29	0.79	0.6551	TAMPA
44	43	0.79	0.6634	ALBANY
45	6	0.71	0.7429	KANSAS CITY
46	37	0.70	0.7526	OKLAHOMA CITY-TULSA
47	11	0.58	0.8573	ORLANDO
48	10	0.57	0.8606	EXURBAN NY
50	36	0.52	0.8963	NEW ORLEANS-MOBILE
51	47	0.39	0.9650	LOUISVILLE
52	21	0.25	0.9953	MILWAUKEE

Table A6. Model 2 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 2 – Chow Test		$H_0: Long\ run\ effect\ for\ PL = Long\ run\ effect\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	11	6.29	0.0025	ORLANDO
2	30	4.74	0.0103	BALTIMORE
3	24	3.59	0.0303	PHILADELPHIA
4	29	3.17	0.0450	TAMPA
5	43	2.92	0.0572	ALBANY
6	39	2.59	0.0791	RALEIGH-DURHAM
7	28	2.24	0.1101	ST. LOUIS
8	51	2.12	0.1239	SAN ANTONIO
9	5	1.77	0.1749	JACKSONVILLE
10	38	1.56	0.2139	PHOENIX
11	52	1.52	0.2221	SYRACUSE
12	48	1.32	0.2701	OMAHA
13	34	1.16	0.3178	LITTLE ROCK
14	20	1.15	0.3190	MIAMI
15	8	1.09	0.3392	SURBURBAN NY
16	12	1.01	0.3677	SAN FRANCISCO
17	49	0.98	0.3793	RICHMOND
18	42	0.87	0.4225	WASHINGTON, DC
19	3	0.85	0.4315	HOUSTON
20	19	0.73	0.4815	DETROIT
21	23	0.70	0.5005	NASHVILLE
22	9	0.70	0.5008	URBAN NY
23	2	0.65	0.5221	CHICAGO
24	44	0.63	0.5340	CHARLOTTE
25	17	0.60	0.5518	DALLAS
26	36	0.54	0.5834	NEW ORLEANS-MOBILE
27	14	0.50	0.6048	ATLANTA
28	45	0.47	0.6254	DES MOINES
29	35	0.46	0.6315	MEMPHIS
30	10	0.43	0.6500	EXURBAN NY
31	41	0.40	0.6733	COLUMBUS
32	26	0.39	0.6769	PORTLAND, OR
33	18	0.39	0.6812	DENVER
34	32	0.36	0.6992	BUFFALO-ROCHESTER
35	6	0.30	0.7383	KANSAS CITY

36	16	0.27	0.7634	CLEVELAND
37	22	0.26	0.7743	MINNEAPOLIS
38	37	0.20	0.8176	OKLAHOMA CITY-TULSA
39	4	0.19	0.8273	INDIANAPOLIS
40	46	0.16	0.8528	GRAND RAPIDS
41	21	0.12	0.8835	MILWAUKEE
42	25	0.10	0.9079	PITTSBURGH
43	40	0.09	0.9103	SALT LAKE CITY
44	31	0.09	0.9120	BIRMINGHAM
45	13	0.05	0.9535	SEATTLE
46	15	0.04	0.9602	CINCINNATI
47	1	0.04	0.9617	BOSTON
48	50	0.03	0.9739	SACRAMENTO
49	7	0.02	0.9768	LOS ANGELES
50	33	0.02	0.9776	HARTFORD-NEW HAVEN
51	47	0.00	0.9967	LOUISVILLE

Table A7. Model 2 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 2 – Chow Test		$H_0: Long\ run\ increase\ for\ PL = Long\ run\ increase\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	30	7.67	0.0064	BALTIMORE
2	29	4.76	0.031	TAMPA
3	28	4.11	0.0447	ST. LOUIS
4	43	3.24	0.0741	ALBANY
5	11	2.75	0.0996	ORLANDO
6	24	2.46	0.1188	PHILADELPHIA
7	38	2.46	0.1193	PHOENIX
8	8	2.09	0.151	SURBURBAN NY
9	12	2.01	0.1587	SAN FRANCISCO
10	34	1.93	0.1673	LITTLE ROCK
11	19	1.47	0.2275	DETROIT
12	9	1.37	0.2433	URBAN NY
13	20	1.37	0.2437	MIAMI
14	2	1.06	0.3049	CHICAGO
15	36	1.04	0.3092	NEW ORLEANS-MOBILE
16	14	1.01	0.3171	ATLANTA
17	39	0.98	0.324	RALEIGH-DURHAM
18	52	0.75	0.3878	SYRACUSE
19	49	0.74	0.3925	RICHMOND
20	51	0.61	0.4352	SAN ANTONIO
21	35	0.59	0.4439	MEMPHIS
22	42	0.54	0.4648	WASHINGTON, DC
23	18	0.46	0.4974	DENVER
24	22	0.43	0.5146	MINNEAPOLIS
25	16	0.39	0.5322	CLEVELAND
26	48	0.39	0.5348	OMAHA
27	17	0.3	0.5851	DALLAS
28	4	0.26	0.6087	INDIANAPOLIS
29	32	0.26	0.6096	BUFFALO-ROCHESTER
30	23	0.26	0.6124	NASHVILLE
31	46	0.2	0.6589	GRAND RAPIDS
32	25	0.19	0.661	PITTSBURGH
33	44	0.19	0.6621	CHARLOTTE
34	5	0.19	0.6644	JACKSONVILLE
35	3	0.16	0.6906	HOUSTON

36	41	0.16	0.6913	COLUMBUS
37	40	0.08	0.7818	SALT LAKE CITY
38	21	0.07	0.7869	MILWAUKEE
39	10	0.06	0.8076	EXURBAN NY
40	26	0.05	0.8302	PORTLAND, OR
41	45	0.04	0.8428	DES MOINES
42	6	0.03	0.8532	KANSAS CITY
43	15	0.02	0.8989	CINCINNATI
44	50	0.01	0.9337	SACRAMENTO
45	7	0.00	0.9466	LOS ANGELES
46	47	0.00	0.9615	LOUISVILLE
47	31	0.00	0.9645	BIRMINGHAM
48	1	0.00	0.9841	BOSTON
49	37	0.00	0.9895	OKLAHOMA CITY-TULSA
50	13	0.00	0.9902	SEATTLE
51	33	0.00	0.9955	HARTFORD-NEW HAVEN

Table A8. Model 2 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 2 – Chow Test		$H_0: Long\ run\ decrease\ for\ PL = Long\ run\ decrease\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	30	8.34	0.0045	BALTIMORE
2	29	5.22	0.0239	TAMPA
3	43	3.81	0.0531	ALBANY
4	11	3.72	0.0557	ORLANDO
5	28	3.72	0.0558	ST. LOUIS
6	24	3.16	0.0778	PHILADELPHIA
7	38	2.71	0.1021	PHOENIX
8	8	2.15	0.1446	SURBURBAN NY
9	12	1.87	0.1736	SAN FRANCISCO
10	34	1.75	0.1885	LITTLE ROCK
11	19	1.45	0.2306	DETROIT
12	39	1.41	0.2371	RALEIGH-DURHAM
13	9	1.39	0.2405	URBAN NY
14	20	1.17	0.2818	MIAMI
15	36	1.07	0.3024	NEW ORLEANS-MOBILE
16	52	1.02	0.3133	SYRACUSE
17	14	0.99	0.3209	ATLANTA
18	51	0.94	0.3328	SAN ANTONIO
19	2	0.94	0.3347	CHICAGO
20	49	0.93	0.3374	RICHMOND
21	42	0.70	0.4037	WASHINGTON, DC
22	35	0.67	0.4136	MEMPHIS
23	48	0.66	0.4185	OMAHA
24	16	0.44	0.5072	CLEVELAND
25	22	0.38	0.5386	MINNEAPOLIS
26	23	0.37	0.5439	NASHVILLE
27	18	0.36	0.5475	DENVER
28	32	0.33	0.5655	BUFFALO-ROCHESTER
29	4	0.30	0.5849	INDIANAPOLIS
30	44	0.29	0.5914	CHARLOTTE
31	3	0.27	0.6022	HOUSTON
32	46	0.23	0.6331	GRAND RAPIDS
33	17	0.20	0.6546	DALLAS
34	25	0.19	0.6620	PITTSBURGH
35	40	0.10	0.7507	SALT LAKE CITY

36	21	0.10	0.7526	MILWAUKEE
37	26	0.10	0.7581	PORTLAND, OR
38	41	0.09	0.7587	COLUMBUS
39	5	0.07	0.7869	JACKSONVILLE
40	15	0.02	0.8773	CINCINNATI
41	10	0.02	0.8778	EXURBAN NY
42	7	0.01	0.9138	LOS ANGELES
43	6	0.01	0.9318	KANSAS CITY
44	31	0.01	0.9319	BIRMINGHAM
45	45	0.01	0.9411	DES MOINES
46	37	0.00	0.9449	OKLAHOMA CITY-TULSA
47	47	0.00	0.9566	LOUISVILLE
48	13	0.00	0.9630	SEATTLE
49	50	0.00	0.9707	SACRAMENTO
50	33	0.00	0.9877	HARTFORD-NEW HAVEN
51	1	0.00	0.9939	BOSTON

Table A9. Model 3 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 3 – Chow Test		$H_0: Long\ run\ effect\ for\ PL = Long\ run\ effect\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	14	5.00	0.0081	ATLANTA
2	42	4.90	0.0089	WASHINGTON, DC
3	7	4.40	0.0141	LOS ANGELES
4	49	4.33	0.0151	RICHMOND
5	25	4.31	0.0154	PITTSBURGH
6	38	3.25	0.0419	PHOENIX
7	41	3.04	0.0512	COLUMBUS
8	51	2.87	0.0605	SAN ANTONIO
9	19	2.86	0.0612	DETROIT
10	30	2.47	0.0889	BALTIMORE
11	28	2.46	0.0893	ST. LOUIS
12	17	2.20	0.1151	DALLAS
13	34	2.18	0.1176	LITTLE ROCK
14	26	2.11	0.1248	PORTLAND, OR
15	20	1.97	0.1435	MIAMI
16	48	1.81	0.1680	OMAHA
17	32	1.80	0.1702	BUFFALO-ROCHESTER
18	36	1.64	0.1971	NEW ORLEANS-MOBILE
19	46	1.64	0.1976	GRAND RAPIDS
20	39	1.62	0.2022	RALEIGH-DURHAM
21	43	1.56	0.2134	ALBANY
22	29	1.46	0.2358	TAMPA
23	24	1.33	0.2687	PHILADELPHIA
24	1	1.24	0.2938	BOSTON
25	23	1.22	0.2990	NASHVILLE
26	33	1.18	0.3101	HARTFORD-NEW HAVEN
27	9	1.18	0.3108	URBAN NY
28	35	1.17	0.3148	MEMPHIS
29	8	1.09	0.3395	SURBURBAN NY
30	22	1.09	0.3403	MINNEAPOLIS
31	31	1.08	0.3418	BIRMINGHAM
32	50	1.05	0.3537	SACRAMENTO
33	5	0.98	0.3779	JACKSONVILLE
34	18	0.94	0.3950	DENVER
35	12	0.77	0.4638	SAN FRANCISCO

36	45	0.72	0.4871	DES MOINES
37	13	0.63	0.5327	SEATTLE
38	2	0.62	0.5376	CHICAGO
39	44	0.46	0.6303	CHARLOTTE
40	10	0.44	0.6426	EXURBAN NY
41	11	0.36	0.6971	ORLANDO
42	6	0.36	0.7012	KANSAS CITY
43	16	0.30	0.7405	CLEVELAND
44	4	0.28	0.7554	INDIANAPOLIS
45	47	0.26	0.7704	LOUISVILLE
46	40	0.24	0.7876	SALT LAKE CITY
47	15	0.15	0.8606	CINCINNATI
48	52	0.11	0.8940	SYRACUSE
49	37	0.05	0.9489	OKLAHOMA CITY-TULSA
50	21	0.01	0.9935	MILWAUKEE
51	3	0.00	0.9977	HOUSTON

Table A10. Model 3 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 3 – Chow Test		$H_0: Long\ run\ increase\ for\ PL = Long\ run\ increase\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	7	8.46	0.0043	LOS ANGELES
2	41	5.46	0.0210	COLUMBUS
3	25	5.13	0.0252	PITTSBURGH
4	19	4.56	0.0345	DETROIT
5	28	4.04	0.0464	ST. LOUIS
6	14	3.99	0.0478	ATLANTA
7	38	3.38	0.0682	PHOENIX
8	17	2.93	0.0891	DALLAS
9	29	2.57	0.1117	TAMPA
10	1	2.47	0.1188	BOSTON
11	49	2.04	0.1553	RICHMOND
12	50	1.93	0.1673	SACRAMENTO
13	42	1.86	0.1751	WASHINGTON, DC
14	43	1.72	0.1922	ALBANY
15	22	1.71	0.1933	MINNEAPOLIS
16	46	1.57	0.2120	GRAND RAPIDS
17	51	1.57	0.2131	SAN ANTONIO
18	9	1.51	0.2217	URBAN NY
19	23	1.40	0.2392	NASHVILLE
20	34	1.31	0.2548	LITTLE ROCK
21	30	1.12	0.2919	BALTIMORE
22	39	1.03	0.3128	RALEIGH-DURHAM
23	2	1.02	0.3149	CHICAGO
24	12	1.02	0.3150	SAN FRANCISCO
25	35	0.76	0.3842	MEMPHIS
26	8	0.73	0.3929	SURBURBAN NY
27	5	0.73	0.3943	JACKSONVILLE
28	44	0.68	0.4104	CHARLOTTE
29	10	0.47	0.4953	EXURBAN NY
30	33	0.43	0.5135	HARTFORD-NEW HAVEN
31	48	0.41	0.5214	OMAHA
32	18	0.31	0.5790	DENVER
33	15	0.27	0.6026	CINCINNATI
34	36	0.27	0.6063	NEW ORLEANS-MOBILE
35	52	0.22	0.6386	SYRACUSE

36	31	0.19	0.6642	BIRMINGHAM
37	40	0.17	0.6848	SALT LAKE CITY
38	24	0.16	0.6875	PHILADELPHIA
39	4	0.16	0.6925	INDIANAPOLIS
40	45	0.13	0.7194	DES MOINES
41	16	0.08	0.7781	CLEVELAND
42	11	0.08	0.7798	ORLANDO
43	37	0.07	0.7853	OKLAHOMA CITY-TULSA
44	20	0.05	0.8155	MIAMI
45	26	0.03	0.8591	PORTLAND, OR
46	13	0.02	0.8924	SEATTLE
47	21	0.01	0.9142	MILWAUKEE
48	32	0.01	0.9247	BUFFALO-ROCHESTER
49	47	0.01	0.9386	LOUISVILLE
50	6	0.00	0.9887	KANSAS CITY
51	3	0.00	0.9977	HOUSTON

Table A11. Model 3 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 3 – Chow Test		$H_0: Long\ run\ decrease\ for\ PL = Long\ run\ decrease\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	7	8.81	0.0036	LOS ANGELES
2	28	4.89	0.0287	ST. LOUIS
3	41	4.59	0.0340	COLUMBUS
4	25	3.63	0.0588	PITTSBURGH
5	19	3.51	0.0634	DETROIT
6	29	2.92	0.0898	TAMPA
7	43	2.43	0.1218	ALBANY
8	30	2.31	0.1312	BALTIMORE
9	1	2.12	0.1475	BOSTON
10	17	1.90	0.1700	DALLAS
11	38	1.70	0.1942	PHOENIX
12	50	1.51	0.2211	SACRAMENTO
13	5	1.37	0.2439	JACKSONVILLE
14	14	1.28	0.2592	ATLANTA
15	8	1.23	0.2701	SURBURBAN NY
16	2	1.23	0.2702	CHICAGO
17	22	1.15	0.2846	MINNEAPOLIS
18	36	1.13	0.2901	NEW ORLEANS-MOBILE
19	9	1.04	0.3086	URBAN NY
20	46	1.02	0.3136	GRAND RAPIDS
21	44	0.88	0.3501	CHARLOTTE
22	45	0.75	0.3895	DES MOINES
23	33	0.72	0.3973	HARTFORD-NEW HAVEN
24	12	0.69	0.4093	SAN FRANCISCO
25	23	0.65	0.4216	NASHVILLE
26	10	0.60	0.4418	EXURBAN NY
27	49	0.51	0.4781	RICHMOND
28	39	0.45	0.5048	RALEIGH-DURHAM
29	32	0.39	0.5346	BUFFALO-ROCHESTER
30	51	0.39	0.5351	SAN ANTONIO
31	15	0.30	0.5872	CINCINNATI
32	42	0.28	0.5996	WASHINGTON, DC
33	52	0.22	0.6381	SYRACUSE
34	16	0.22	0.6388	CLEVELAND
35	34	0.15	0.6998	LITTLE ROCK

36	37	0.10	0.7515	OKLAHOMA CITY-TULSA
37	47	0.09	0.7696	LOUISVILLE
38	35	0.09	0.7705	MEMPHIS
39	6	0.08	0.7720	KANSAS CITY
40	20	0.08	0.7735	MIAMI
41	4	0.08	0.7818	INDIANAPOLIS
42	31	0.07	0.7956	BIRMINGHAM
43	40	0.06	0.7996	SALT LAKE CITY
44	24	0.06	0.8071	PHILADELPHIA
45	26	0.05	0.8214	PORTLAND, OR
46	18	0.02	0.8851	DENVER
47	48	0.02	0.8998	OMAHA
48	21	0.01	0.9197	MILWAUKEE
49	13	0.01	0.9264	SEATTLE
50	11	0.01	0.9397	ORLANDO
51	3	0.00	0.9914	HOUSTON

Table A12. Model 1 Chow Test comparing Long run Effect of Farm Price Shocks on Private Label and National Brand Retail Prices.

Model 1 – Chow Test		$H_0: Long\ run\ effect\ for\ PL = Long\ run\ effect\ for\ NB$		
Obs	MarketID	F-Value	Prob>F	City
1	30	2.02	0.1606	BALTIMORE
2	8	1.27	0.2633	SURBURBAN NY
3	7	1.15	0.2868	LOS ANGELES
4	51	1.10	0.2985	SAN ANTONIO
5	50	0.92	0.3400	SACRAMENTO
6	43	0.90	0.3459	ALBANY
7	4	0.81	0.3718	INDIANAPOLIS
8	44	0.76	0.3879	CHARLOTTE
9	5	0.55	0.4616	JACKSONVILLE
10	15	0.55	0.4627	CINCINNATI
11	35	0.54	0.4664	MEMPHIS
12	28	0.49	0.4848	ST. LOUIS
13	48	0.38	0.5379	OMAHA
14	22	0.37	0.5434	MINNEAPOLIS
15	20	0.37	0.5456	MIAMI
16	9	0.36	0.5502	URBAN NY
17	6	0.35	0.5580	KANSAS CITY
18	47	0.31	0.5816	LOUISVILLE
19	31	0.26	0.6090	BIRMINGHAM
20	17	0.25	0.6162	DALLAS
21	11	0.24	0.6234	ORLANDO
22	16	0.21	0.6515	CLEVELAND
23	37	0.20	0.6570	OKLAHOMA CITY-TULSA
24	21	0.19	0.6604	MILWAUKEE
25	36	0.18	0.6753	NEW ORLEANS-MOBILE
26	12	0.14	0.7111	SAN FRANCISCO
27	3	0.14	0.7128	HOUSTON
28	29	0.13	0.7153	TAMPA
29	34	0.13	0.7196	LITTLE ROCK
30	42	0.12	0.7323	WASHINGTON, DC
31	18	0.11	0.7377	DENVER
32	52	0.10	0.7584	SYRACUSE
33	23	0.09	0.7600	NASHVILLE
34	49	0.09	0.7611	RICHMOND
35	41	0.09	0.7647	COLUMBUS

36	26	0.09	0.7669	PORTLAND, OR
37	14	0.08	0.7729	ATLANTA
38	25	0.08	0.7745	PITTSBURGH
39	33	0.08	0.7795	HARTFORD-NEW HAVEN
40	1	0.08	0.7833	BOSTON
41	32	0.05	0.8199	BUFFALO-ROCHESTER
42	10	0.05	0.8208	EXURBAN NY
43	45	0.05	0.8307	DES MOINES
44	2	0.05	0.8308	CHICAGO
45	39	0.04	0.8493	RALEIGH-DURHAM
46	19	0.01	0.9233	DETROIT
47	24	0.01	0.9293	PHILADELPHIA
48	38	0.01	0.9439	PHOENIX
49	46	0.00	0.9614	GRAND RAPIDS
50	13	0.00	0.9794	SEATTLE
51	40	0.00	0.9892	SALT LAKE CITY

Appendix B: Figures

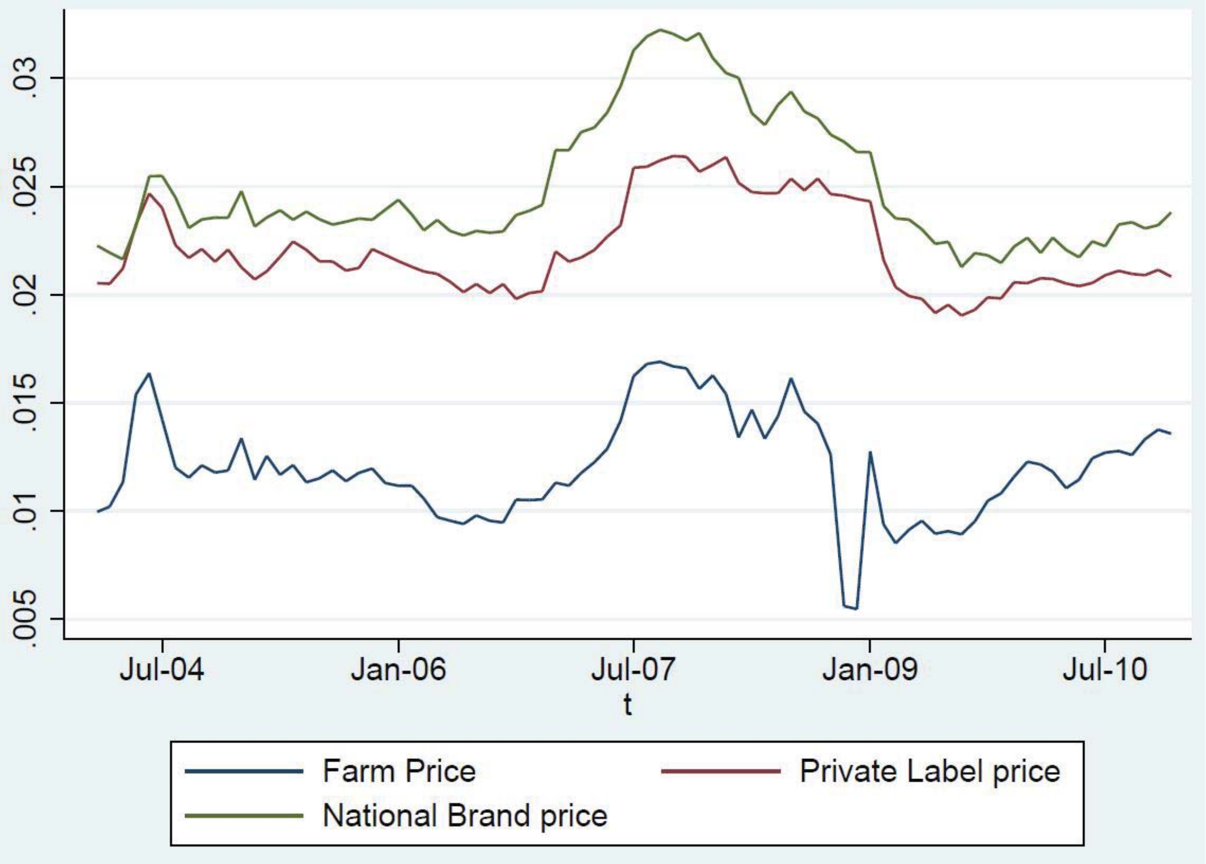

Figure B1. Average Monthly Retail Prices and Regional Farm Price ($/FlOz) for Milk sold in Gallons, Boston, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan and USDA-NASS Data).

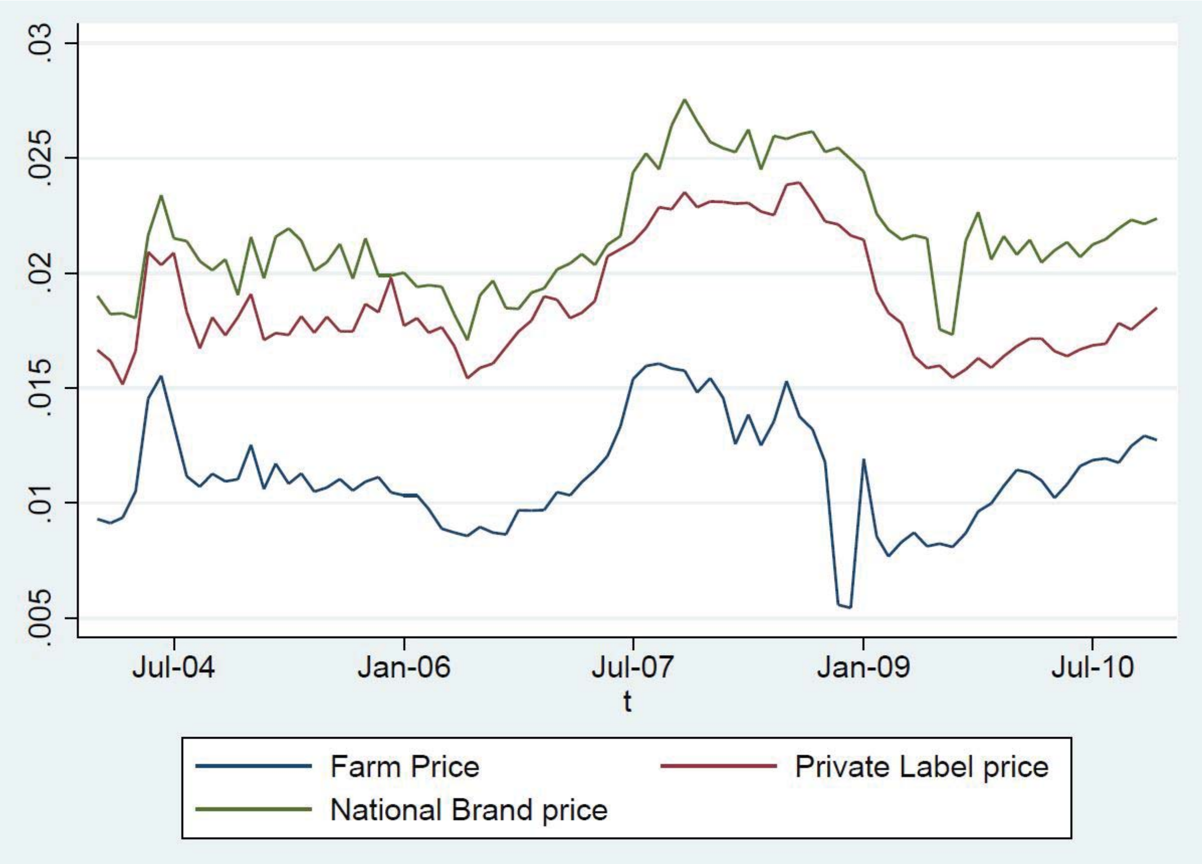

Figure B2. Average Monthly Retail Prices and Regional Farm Price ($/FlOz) for Milk sold in Gallons, Indianapolis, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan and USDA-NASS Data).

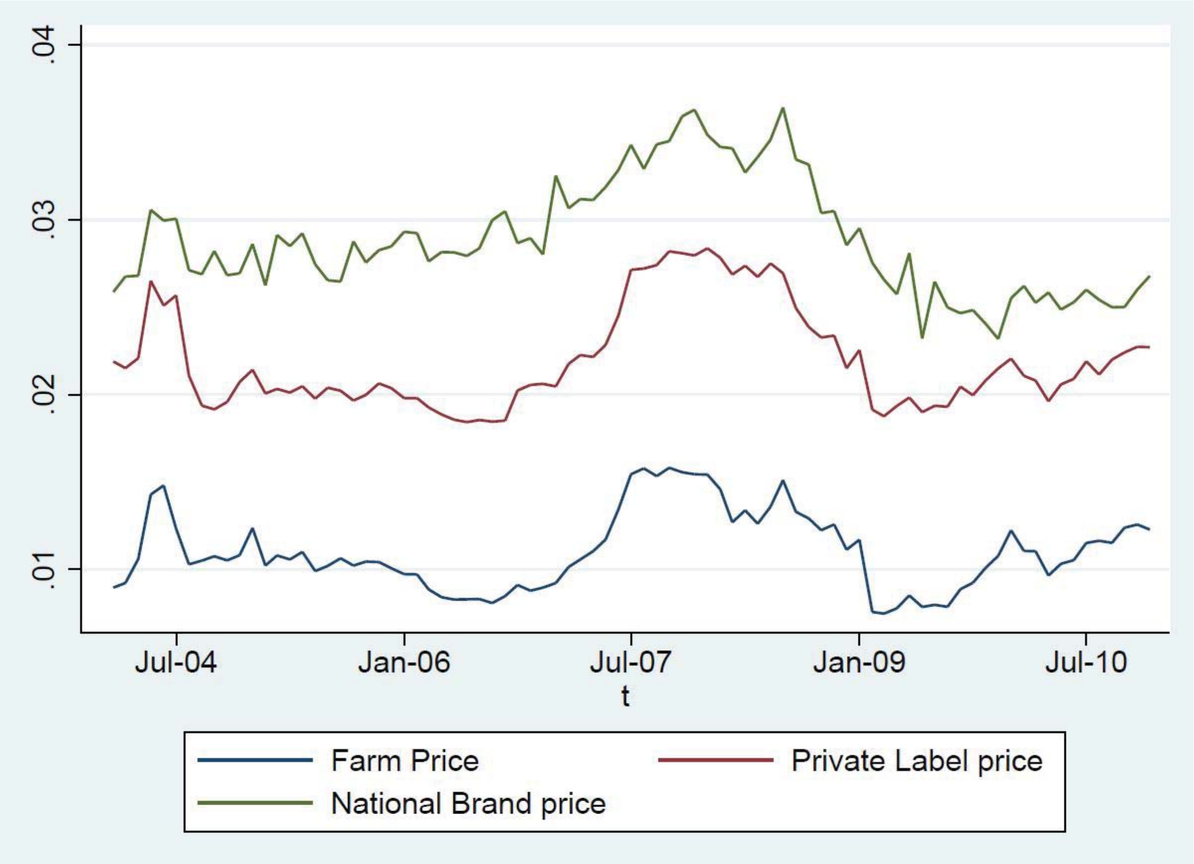

Figure B3. Average Monthly Retail Prices and Regional Farm Price ($/FlOz) for Milk sold in Gallons, San Francisco, January 2004-December 2010 (source: Author's Calculations from Nielsen Homescan and USDA-NASS Data).

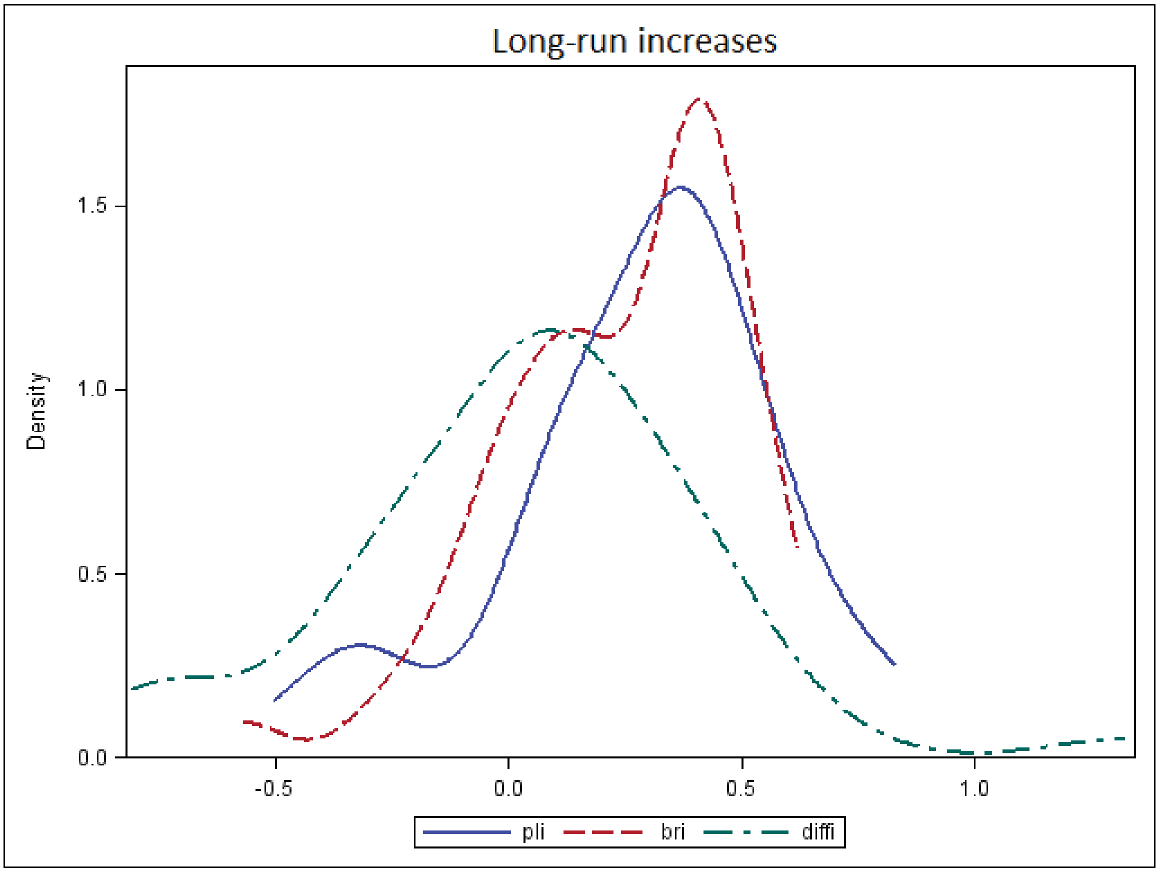

Figure B4: Kernel Density Plot for $\sum_{m=0}^{5} \gamma_m^{Private\ Label(+)}$(“pli”), $\sum_{m=0}^{5} \gamma_m^{National\ Brand(+)}$(“bri”), and $\sum_{m=0}^{5} \gamma_m^{Private\ Label(+)} - \sum_{m=0}^{5} \gamma_m^{National\ Brand(+)}$(“diffi”).

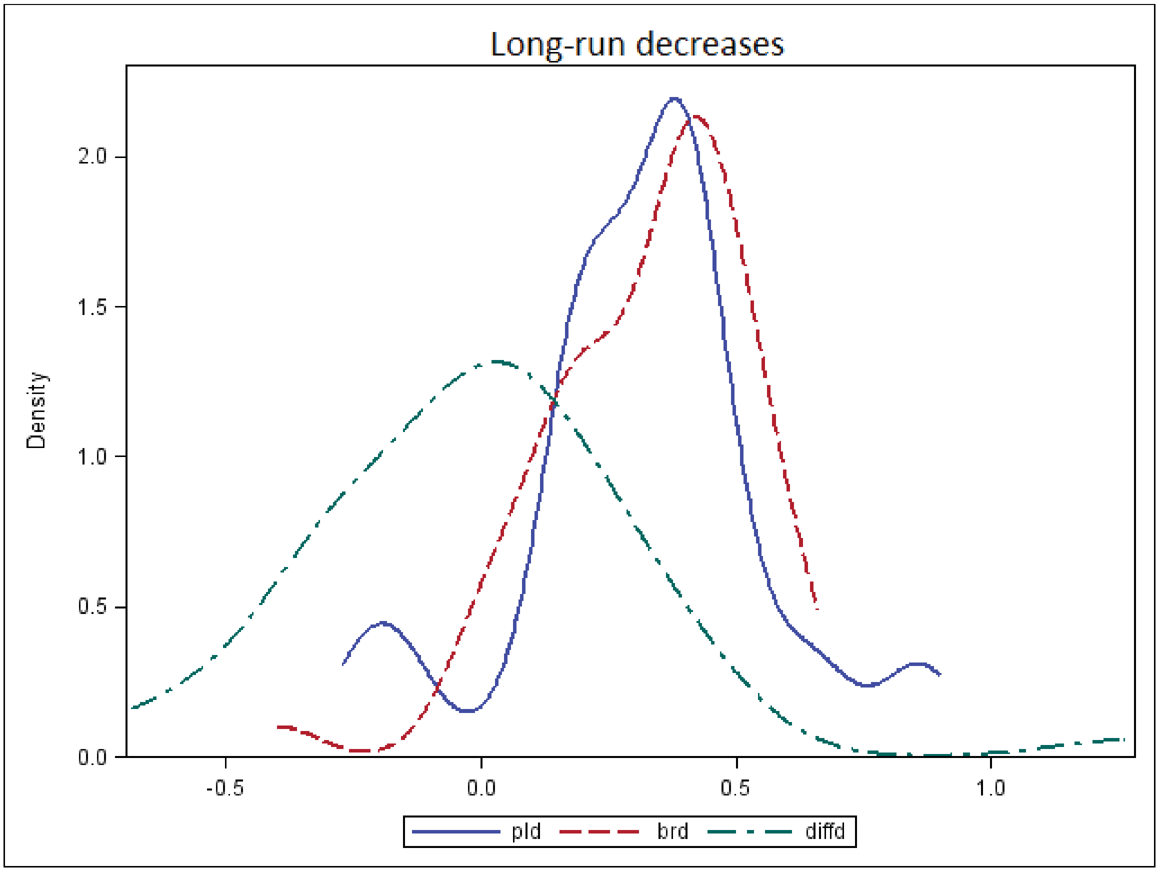

Figure B5: Kernel Density Plot for $\sum_{m=0}^{5} \gamma_m^{Private\ Label(-)}$("pld"), $\sum_{m=0}^{5} \gamma_m^{National\ Brand(-)}$ ("brd"), and $\sum_{m=0}^{5} \gamma_m^{Private\ Label(-)} - \sum_{m=0}^{5} \gamma_m^{National\ Brand(-)}$("diffd").