Heterogeneous Effects of Private Label and Branded Products on Farm-Retail Price Transmission: The Case of the U.S. Fluid Milk Market

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Abstract

The asymmetric farm-retail transmission has been well documented in the general fluid milk market. However, little attention has been given to the possible heterogeneous cost pass-through process of private labels. Given the leading role of private labels in the fluid milk market, it is of special interest to focus on its possible heterogeneous effects on farm-retail price transmission. In this paper, we examine the heterogeneous effects of private label and branded product on price transmission asymmetry in the fluid milk market. We incorporate the Houck (1977) procedure to specify and estimate the farm-retail pass-through, which segments the farm prices into increasing and decreasing phases separately. To capture the heterogeneous effects of brand types on price transmission, we include interaction terms of brand type dummies with increasing and decreasing phases of farm price and then test the asymmetry in farm-retail pass-through for different brand types. Our results indicate that private label and branded milk all show asymmetry in price transmission. However, brand types affect the magnitudes of the asymmetry and private label milk presents the lowest asymmetry in price transmission, compared with national and regional branded milk. One possible explanation is that retail chains have a greater ability to affect prices of their own private label products through integrated distribution channels and thus impose a strong mitigation power of the asymmetry in farm-retail price transmission.

Keywords: price transmission, cost pass-through, retail pricing, private label

1. Introduction

There has been a steady decline in milk consumption over the last half a century that has been combined with a decrease in the number of dairy farms. While many reasons exist for this shift in the dairy industry, an asymmetric price response in the farm-retail price transmission has been considered as one contributing factor (Bentley, 2014), In particular, it has been shown in the literature that retail prices respond to farm price increases more rapidly than farm price decreases (Kinnucan and Forker 1987; Carman and Sexton. 2005; Lass 2005; Capps and Sherwell 2007; Bolotova and Novakovic 2012; Loy et al. 2014). One major concern of the asymmetric price responses is that, retailers are primed to earn excess profits when retail prices lag in response to farm price decreases while farmers do not enjoy the same benefit when retailers increase prices more rapidly than farm price increases. While these findings are consistently found in previous studies, there is no evidence that the relationship holds true when considering the retailers own brand where retailers have a greater ability to set and adjust the retail prices directly. A contributing factor to this differentiated pricing strategy is that in fluid milk the retailers' own store brand (private label) represents a dominant and growing presence in the market, with a market share over 50%. Given the leading role of private labels in the fluid milk market, it is of special interest to focus on the possible heterogeneous effects on farm-retail price transmission of private label products versus branded products.

Differing impacts of farm-retail price transmission of private label products can come from multiple sources. On one hand, the dominating market share of private label fluid milk leads to market power, higher mark-ups and thus potentially lower cost pass-through, compared to branded milk. On the other hand, branded milk typically engages in a greater degree of advertising and promotion, which are commonly used marketing strategies to manifest the differentiation of name brands and to maintain and increase market power (Parker and Kim, 1997, Steiner, 2004). On the contrary, private label milk, as a low price alternative, is usually consumed by price sensitive consumers. It is also established that the effect of prices on competition between private labels and branded products are asymmetric (Blattberg and Wisniewski, 1989: Sethuraman (1990), Cotterill and Putsis, 2000, Steiner 2004). In particular, Steiner (2004) finds that national brands lose fewer sales to private label products when the price of national brands increase as compared to the loss in sales of private label products when the private label price rises. Therefore, it is possible that the retail price adjustment to farm price changes might be different between private labels and national brands, especially during times of increasing farm prices. Specifically, the retailers pricing strategy in response to farm price changes might be where private labels need to be more prudent when increasing their own brand prices compared to price changes of national brands.

Another contributing factor to potential heterogeneity in the farm-retail price transmission between private label and branded milk might be due to the differences in vertical structure. Private label, which is considered as an intra-firm product for retailers, generally exhibits greater flexibility in prices (Hong and Li, 2016). When name brands offer trade deals to retailers to motivate temporary in-store price reductions, fewer than 50 percent of the wholesale price reduction gets passed on to the consumer (Hoch, 1996). Compared to name brands, the integrated vertical structure can reduce or eliminate the markups for private labels, resulting in more symmetric farm-retail price transmission for private label products. Overall, the actual net impact of private labels on farm-retail price transmission depends on which effect dominates and thus empirical estimation is of interest.

To examine the heterogeneous effects of brand types on price transmission asymmetry, we incorporate the Houck (1977) procedure to specify and estimate the farm-retail pass-through based on increasing and decreasing farm prices. We classify milk brands into three categories: private label, regional brand, and national brand. To capture the heterogeneous effects of brand types on price transmission, we include interaction terms of brand type dummies with increasing and decreasing phases of farm price and then test the asymmetry in farm-retail pass-through for different brand types.

This paper is closely related to previous studies on farm-retail price transmission. Focusing on the dairy sector, Kinnucan and Forker (1987) use the Houck procedure to estimate price transmission and find that increases in the farm prices are transmitted more fully than farm price decreases. Vavra1 and Goodwin (2005) discuss the extent of the retail price adjustment to farm price, the timing of the adjustment and the extent to which adjustments are asymmetric. Peltzman (2000) even claimed that the asymmetric price transmission is the rule rather than the exception. The reason of asymmetry also gains considerable attentions. Many arguments blame the problem at the retail level. That is, non-competitive behavior in the market place causes a “stickiness” in retail prices (Zachariasse et al., 2003, Vavra1 and Goodwin, 2005). However, pure market power cannot precisely explain the whole story. For example, in an oligopoly context, both positive and negative asymmetry price transmission are conceivable, depending on market structure and conduct (Meyer and Cramon-Taubadel, 2004). Alternative explanations are government intervention Kinnucan and Forker (1987), menu cost (Ball and Mankiw, 1994), inventory management (Reagan and Weitzman, 1982) and consumer search costs (Tappata, 2009).

Our results indicate that private label and branded milk all show asymmetry in price transmission. However, we find the magnitude of the asymmetry differs by brand type with private label milk representing the lowest asymmetry in price transmission. One possible explanation is that retail chains have a greater ability to affect prices of their own private label products through integrated distribution channels and thus impose a strong mitigation power of the asymmetry in farm-retail price transmission. This raises questions about the source of asymmetric price transmission found in previous studies and whether processors are contributing to the differences in farm-retail pricing.

The rest of the paper is organized as follows. Section 2 introduces the empirical model. Section 3 describes the data and summary statistics. Section 4 presents the estimation results and Section 5 concludes the paper

2. Model Specification

To specify and estimate the farm-retail pass-through, we incorporate the Houck (1977) procedure, which has been used extensively in previous empirical studies (Kinnucan and Forker, 1987; Lass, 2005; Lass et al., 2001, Bolotova and Novakovic, 2012). The Houck procedure segments the farm prices into increasing and decreasing phases separately and tests the asymmetry in price transmission based on the differential effects of these two phases on retail prices.

In this analysis, a milk product is defined as a combination of its brand, butterfat content and container size. For example, a one-gallon whole milk of Hood and a half-gallon whole milk of Hood are considered as two different products. We then classify milk products into three categories;

private labels (store brands), regional brand, and national brand products according to their brand descriptions and sale records in different states. The empirical specification is given by the following equation:

$$R_{ijt}^{*} = \pi_0 Trend_t + \sum_{k=0}^{2} \pi_{1,k} FR_{ij,t-k}^{*} + \sum_{k=0}^{2} \pi_{2,k} FF_{ij,t-k}^{*}$$

$$+ \sum_{k=0}^{2} \pi_{3,k} FR_{ij,t-k}^{*} * NB_{it} + \sum_{k=0}^{2} \pi_{4,k} FF_{ij,t-k}^{*} * NB_{it}$$

$$+ \sum_{k=0}^{2} \pi_{5,k} FR_{ij,t-k}^{*} * RE_{it} + \sum_{k=0}^{2} \pi_{6,k} FF_{ij,t-k}^{*} * RE_{it}$$

$$+\beta_1 Plastic_{jt}^{*} + \beta_2 Electricity_{jt}^{*} + \beta_3 Wages_{jt}^{*} + \beta_4 living_{jt}^{*} + \beta_5 Concentration_{jt}^{*}$$

$$+ \sum_{l=0}^{3} \beta_{5,l} Type_i + \sum_{l=0}^{2} \beta_{6,l} Size_i + \varepsilon_{ijt} \quad (1)$$

where R_{ijt}^{*} is the retail price deviation from its initial value of milk product *i* in state *j* at time *t*, and $Trend_t$ is a time trend term. FR_{ijt}^{*} is the sum of period-to-period farm price rising and FF_{ijt}^{*} is the sum of period-to-period farm price falling from the initial value of farm price of milk product *i* in state *j* at time *t*. FR_{ijt}^{*} is always positive and FF_{ijt}^{*} is always negative according to the Houck procedure. A two-period lag is assumed following Lass, Adanu, and Allen (2001).[1]

In this analysis, we focus on the heterogeneous effects of three brand types on price transmission. Using private labels as a base, NB_{it} is a dummy variable that equals to 1 if product *i* is a national brand and RE_{it} is a dummy variable that equals to 1 if product *i* is a regional brand. There are multiple reasons to distinguish between regional brands and national brands. First, food products from ones' own region are usually preferred to products with an unknown origin (Alvensleben and Schrader, 1998). Johnson and Bruwer (2007) also found that the addition of regional information on a label increased consumer confidence in the quality of the product. Thus, regional brands tend to take advantage of their regional/local image to build consumer loyalty. Alternatively, these regional brands typically have a smaller production scale, compared to national brands, resulting in greater impacts due to changes in input costs, while national brands have a greater ability to deal with these changes through larger production portfolios. Therefore,

[1] Lass, Adanu, and Allen (2001) find that inclusion of one-month and two-month lagged values worked the best through investigations using national data.

the retail price of regional brands may respond differently to farm price changes, compared with national brands and private labels. Therefore, to test the asymmetry in farm to retail price pass-through, we include interaction terms of the brand type dummies during periods of increasing farm prices (FR_{ijt}^{*}) and falling farm prices (FF_{ijt}^{*}). In addition, the two period lags of the interaction terms are also included to capture the carry-over effects.

We control for other factors which may influence retail prices such as cost shifters, living expenses and retail concentrations. As for cost shifters, we focus primarily on the processing costs and retailing costs, which are the major cost components affecting retail prices. Thus, price indexes of plastic products ($Plastic_{jt}^{*}$), electricity ($Electricity_{jt}^{*}$) and retail wages ($Wages_{jt}^{*}$) are included as proxies for main inputs at the stage of milk bottling, storage and selling. $Living_{jt}^{*}$ is the average personal consumption expenditures per capita of state *j* at time *t*. We use it as a proxy of the cost of living to capture the persistent pricing differences across states over time. $Concentration_{jt}^{*}$ measures the retail concentration level of state *j* at time *t*. Further, $Plastic_{jt}^{*}$, $Electricity_{jt}^{*}$, $Wages_{jt}^{*}$, $Living_{jt}^{*}$, and $Concentration_{jt}^{*}$ are also deviations from their initial values in state *j* at time *t*, respectively. $Type_i$ and $Size_i$ are dummy variables of milk types and package sizes to control for milk butterfat content and container size. Fat-free, one percent and whole milk are listed as dummy variables in the type category, leaving two percent as the base. A quart and half gallon are included as size dummy variables, using one gallon as the base variable.

To determine the heterogeneity in farm-retail price transmission for different types of brands, we conduct several hypothesis tests of asymmetry for both short-run price transmission and long-run price transmission. Specifically, we run the tests in two steps. First, we examine the existence of the short-run and long-run asymmetry in price transmission of each brand type separately. The specification is indicated as Hypothesis Test 1. In the short-run asymmetric price transmission test, we test whether rates of farm-retail price adjustment are the same for increasing versus decreasing farm prices. We then use all lagged effects to test the cumulative long-term effect of equivalent farm price increases and decreases.

Hypothesis Test 1:

	Short Run	Long Run
National Brands	$H_o: \pi_{1,k} + \pi_{3,k} = \pi_{2,k} + \pi_{4,k}$, $k = 0,1,2$	$H_o: \sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{3,k} = \sum_{k=0}^{2} \pi_{2,k} + \sum_{k=0}^{2} \pi_{4,k}$, $k = 0,1,2$
Regional Brands	$H_o: \pi_{1,k} + \pi_{5,k} = \pi_{2,k} + \pi_{6,k}$, $k = 0,1,2$	$H_o: \sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{5,k} = \sum_{k=0}^{2} \pi_{2,k} + \sum_{k=0}^{2} \pi_{6,k}$, $k = 0,1,2$
Private Labels	$H_o: \pi_{1,k} = \pi_{2,k}, k = 0,1,2$	$H_o: \sum_{k=0}^{2} \pi_{1,k} = \sum_{k=0}^{2} \pi_{2,k}$, $k = 0,1,2$

Second, we conduct hypothesis tests to compare the level of long-run farm-retail pass-through among the three types of brands, as illustrated in Hypothesis Test 2 below.

Hypothesis Test 2:

	National Brands	Regional Brands
Private labels	$H_o: \left(\sum_{k=0}^{2} \pi_{1,k} - \sum_{k=0}^{2} \pi_{2,k}\right) = \left(\sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{3,k}\right) - \left(\sum_{k=0}^{2} \pi_{2,i} + \sum_{k=0}^{2} \pi_{4,i}\right)$, $k = 0,1,2$	$H_o: \left(\sum_{k=0}^{2} \pi_{1,k} - \sum_{k=0}^{2} \pi_{2,k}\right) = \left(\sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{5,k}\right) - \left(\sum_{k=0}^{2} \pi_{2,i} + \sum_{k=0}^{2} \pi_{6,i}\right)$, k = 0,1,2
National Brands	N/A	$H_o: \left(\sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{3,k}\right) - \left(\sum_{k=0}^{2} \pi_{2,i} + \sum_{k=0}^{2} \pi_{4,i}\right) = \left(\sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{5,k}\right) - \left(\sum_{k=0}^{2} \pi_{2,i} + \sum_{k=0}^{2} \pi_{6,i}\right)$, $k = 0,1,2$

N/A: Hypothesis testing between national brands and national brands are not applicable.

The second test focuses on whether the differences between the effect of cumulative farm pricing increase and decreases are the same for private label products, national brand products and regional brand products. In other words, we test whether regional brands and national brands have mitigation or amplifying effects on the asymmetry of price transmission, compared with private labels.

3. Data

For this analysis we combine several datasets including the Nielsen Homescan and Retail Scanner data. Both Nielsen data sets are used to collect retail prices of fluid milk in 48 states, excluding Alaska and Hawaii, from January 1, 2006 to December 31, 2011. The Nielsen Homescan data tracks 424,272 households and covers fluid milk purchase and pricing information from all retail outlets including grocery stores, drug stores, and supermarkets in all 48 states. The Nielsen Retail Scanner data are included from approximately 35,000 participating grocery, drug, mass merchandiser, and other stores in all US markets. We use both the Homescan and Scanner data because of their individual advantages with respect to private label and branded products. The Homescan data includes a more comprehensive set of private label products with associated product characteristics, while the Scanner data contains a more complete set of branded products because it doesn't rely on purchase by a Nielsen participating household. Therefore, we calculate the monthly state-level sales-weighted average retail prices of private label milk using the Homescan data and the prices of national and regional brands of milk using Scanner data.

We restricted our analysis to regular, non-organic fluid milk since organic milk is a different market in terms of consumer preferences and production costs, compared with regular milk. In particular, the farm price and retail prices behave differently between these two products. Furthermore, the market share of organic milk is relatively small, only around 3% of the U.S. total (Greene and McBride, 2015). Therefore, we exclude organic milk and focus only on the regular milk market.

To determine whether brands are national or regional we divide the 48 states into 8 regions: New England, Mid-Atlantic, Midwest, Mountain-Plains, Western, Southeast, and Southwest. A brand is considered as a regional brand if it is sold only in one region while a brand is a national brand if it is sold in multiple regions. Private label brands are brands sold only in the retailers own store, regardless of geographic distribution. For example, *Great Value* is Walmart's private label milk which is only sold at Walmart stores. *Mountain Dairy* and *Farmer's Cow*, brands sold only in the New England area, are considered to be regional brands. In contrast, *Dean Foods Dairy Pure* is a national brand that sells nationwide in multiple regions.

Table 1 reports the summary statistics for retail prices in the 48 states. For each milk product, the sales-weighted prices were calculated by aggregating retail prices to the monthly and state level. The average unit retail price for all milk types is $0.036 per ounce. We also break down the average retail milk prices by brand type, fat content and container size. There are significant variations in the average retail prices across different brand types. National brands lead the market with an average price of $0.038 per ounce, followed by regional brands with $0.036 per ounce. Compared with these two brand categories, the average price of private label milk is much lower at $0.030 per ounce. In terms of container sizes, the average unit prices vary from $0.029 per ounce for a one-gallon container to $0.045 per ounce of a 32-ounce container. However, retail prices for milk with different fat content are similar, ranging from $0.034 per ounce for 1-percent milk to $0.037 per ounce for whole milk.

We use Class I fluid milk for farm prices, which represents the cost of farm milk as an input for fluid milk processors and is available from the U.S. Department of Agriculture (USDA) Agricultural Marketing Service Dairy Program. The Federal Milk Marketing Order (FMMO) system determines Class I fluid milk prices and county differentials throughout the U.S. While we recognize that not all geographic areas are covered by FMMO, we use the Class I price and differentials to compute a proxy for the farm price in these non-FMMO areas. Table 2 provides the summary statistics of Class I prices. The average Class I price for all types of milk is $0.01 per ounce. Farm prices rise as the fat content increases and whole milk has the highest mean in farm prices. In addition, the standard deviation of farm prices is smaller than that of retail prices, suggesting diversified farm-retail pricing behaviors.

For a clearer illustration, Figure 1 presents the retail price and Class I milk prices per gallon of whole milk from January 2006 to December 2011. The retail milk prices of all three brand types followed the trend of Class I milk prices closely: declining sharply in late 2008 and early 2009 due to the global economic recession, and recovering slowly starting in late 2009. Furthermore, the prices of all brand types showed the "stickiness" in some periods. For example, during the first two quarters of 2008, Class I prices experienced dramatic fluctuations while retail prices only reacted to the increases in Class I prices. Retail prices remained stable when Class I prices were dropping in the first quarter of 2010. Moreover, compared with private label milk, prices of national brands and regional brands are less responsive to Class I price changes. For example, during the second quarter of 2009, prices of private labels reached the bottom following a substantial drop in Class I prices but national brand and regional brand prices remained at relatively high levels.

Since the portfolio of regional brands and the performance of private label milk vary across regions, it is possible that the geographic variations play an important role in the heterogeneity of asymmetric price transmission for different brand types. Table 3 shows the regional differences of retail and farm prices by brand types. Although there are only slight differences in farm prices among regions, the average retail prices deviate considerably and are higher in the New England, Southeast and Southwest regions. When we break it down by brand types, pricing behaviors vary substantially across regions. The Mid-Atlantic region has the highest price for private labels while the Western area has the highest regional brand pricing. National brands exhibit higher pricing in New England, the Southeast and Southwest. These descriptive statistics imply that the rate of farm-retail price transmission may differ across regions and brand types.

Table 4 provides the summary statistics of all other control variables used in this analysis. We control for other factors which may influence retail and farm prices such as cost shifters, living expenses and retail concentrations. The monthly producer price index of plastic and electricity are included as controls for processing costs, which are collected from the U.S. Bureau of Labor and Statistics (BLS). Weekly wage paid by grocery stores based on the quarterly census of employment and wages are also included to control for retailing costs. In addition, since there might be persistent pricing differences across states, we include the per capita total consumption expenditure, collected from the U.S. Bureau of Economic Analysis (BEA). The average per capita consumption across states is $32,675. Further, retail concentration reflects the intensity of competition between retailers, which may also affect retail pricing. We compute and include the four-firm retail concentration ratio (CR4), the sum of market share of the top four retailers in each market, based on data reported in the Grocery Distribution Guide.

4. Empirical Results

4.1 Heterogeneity in Asymmetric Price Transmissions

Estimation results for the main model specified in Equation 1 are presented in Table 5. Our focus is the differentiated effects of private label and branded milk on the farm-retail price pass through. We first analyzed the differences of adjustment speeds among these brands and then conducted the hypothesis of asymmetry of price transmission individually. Finally, heterogeneous price transmissions are examined by comparing the magnitudes of asymmetry among brand types.

Private labels are used as the base in this estimation. As shown in Table 5, in the current period ($\pi_{1,0}$), rising farm prices have a significant impact on the retail price changes of private labels: a \$1 increase in farm price lead to a \$1.11 increase in the current retail price. However, the estimated coefficients for one-period and two-period lags are not significant for private label milk, suggesting that retail prices of private labels are no longer responding to increases in farm prices from one month or two months prior. When farm prices fall, retail prices of private label milk do not respond immediately to the current period drop, but begin to drop in response to falling farm prices from the previous two periods. Thus retail prices drop by \$0.26 and \$0.61, when there is a \$1 decrease in farm price from the previous one and two months, respectively.

The interaction terms of the brand type dummies with increasing farm prices (FR^{*}_{ijt}) and decreasing farm prices (FF^{*}_{ijt}) of current and previous two periods are estimated to test the brand type heterogeneity in farm to retail price pass-through asymmetry. It is interesting to notice that most interaction terms of rising farm prices with regional and national brand dummies are significant. Therefore, there exists significant heterogeneity in retail price adjustment to rising farm prices among different types of brands. In contrast, almost all interaction terms of falling farm prices with regional and national brand type dummies are not significant. This suggests that, responses of retail milk prices to decreases in the farm prices are not significantly different among national brands, regional brands, and private labels. Overall, these results imply that the magnitude of retail price responses to farm price changes vary depending on the brand types, especially during times of increasing farm prices.

For a clearer comparison, using results from Table 5, we calculate the full retail price responses to rising and falling farm prices for the three brand types. We then conduct the hypothesis test to compare the asymmetry between brand types (Hypothesis 1). The results are shown in Table 6.

We first determine whether single period rising effects are different from single period falling effects in the short run. The p-values of zero indicate the current period rising coefficients are statistically greater than the current period falling coefficient at the 1% level, for all three brand types. During the one-period lag the private label rising coefficient is smaller than the falling coefficient, significant at the 5% level, indicating a correction occurs after one period of rising prices but a delayed response after one period of falling prices. With respect to national brands, the one-period lag indicates a further increase in the pass through rate during periods of rising and falling prices, with the coefficient for falling prices significantly greater than for rising prices. However, for regional brands there is no statistically significant difference in the one-period lag coefficients. The two-period lag coefficients follow the same pattern as the one-period lag, except now the regional brand coefficients are statistically significantly different from each other, with the rising farm price coefficient negative and the falling farm price coefficient positive. Overall, in the short run, there is empirical evidence that asymmetry in price transmission occurs for all brands.

We then consider the net effect after adjustments to both rising and falling farm prices when time is incorporated into retail milk prices. In the model, retail milk price is affected by accumulated rising and falling farm prices in current and previous periods. Therefore, we test a comparison of the sum of the three rising coefficients to the sum of the falling coefficients for all three brand types. The results are reported in the second panel of Table 6. For private label milk, the long-run aggregated response of retail price to farm price rising of $1 is $1.026, while the long-run response of retail price to farm price falling of $1 is $0.932. Hypothesis test results suggest that the difference between the two sums is statistically significant. Similarly, for national brands and regional brands, the p-values are both zeros, suggesting significant differences between these sums. Therefore, the long-run adjustment of retail price to rising farm prices is still more rapid than that to falling farm prices.

Elasticity of price transmission provides further evidence for the unequal responses of retail price to farm price changes for the three categories of brands (Table 7). Short run elasticities of farm price rising vary from 0.261 to 0.390, exceeding the corresponding falling farm price elasticities by about 30%. While in the long run, falling price elasticities increase to at least 0.227, yet there still exists a positive distance between the rising price elasticity and the falling price elasticity, indicating a more fully cost pass through with respect to rising farm prices for all brands.

However, brand types do have differentiated impacts on the magnitude of asymmetry. Specifically, we compare and test the differences between the sum of rising coefficients to the sum of falling coefficients among three brand types (Hypothesis 2). The tests results are reported in Table 8 and the p-values of all tests are zero. For private label milk, the difference between the sum of rising coefficients and sum of falling coefficients are 0.094, which is significantly lower than that of the national brands (0.186) and regional brands (0.173). The result is also consistent with respect to the elasticity of price transmission. For the long run elasticities, private labels have the smallest difference between rising farm prices and falling farm prices. Therefore, in general, the retail price of private label milk follows more closely to farm price changes than competing branded milk. On the contrary, national brands show the highest farm-retail price asymmetry, followed by regional brands.

One possible explanation of the heterogeneous effects on price transmission is the intrinsic characteristics of the three brand types. Compared with private labels, national brands are advertised with relatively loyal consumers, thus having a greater ability to face cost shocks, relating to greater pricing power and lower cost pass-through (Loy et al., 2014). Regional brands can benefit from consumer preferences for region-related labeling but have smaller production scale and geographic recognition. For private label products, even though they enjoy a large market share in the fluid milk market, their prices are closer to marginal cost and exhibit greater flexibility. Further, retail chains have a greater ability to affect prices of their own private label products through their integrated distribution channel and thus impose a strong mitigation power of the asymmetry in farm-retail price transmission.

4.2 Regional Differences

Since the portfolio of regional brands and the performance of private label milk vary across regions, it is possible that the geographic variations play an important role in the heterogeneity of asymmetric price transmission for different brand types. As suggested by Cotterill (2006), there is a substantial regional difference in the cost of production of milk. Moreover, the regional impact of federal, regional, and state polices, and the performance of regional fluid milk marketing channels will also affect the rate of farm-retail price transmission between private label and branded milk.

Therefore, we conduct a further analysis by estimating the impact of regional differences on the heterogeneity of price transmissions between private labels and branded milk. Specifically, we divide the U.S. market into 8 regions and run similar subsample regressions of farm-retail price asymmetry for each region. We calculate the sums of rising coefficients and the sums of falling coefficients, and test the statistical significance of differences between these sums for each region. The results are presented in Table 9. For most regions, the heterogeneous effects of brand types on price transmission asymmetry still exist. Most regions show long term asymmetry for all brand types, following the same conclusion obtained in the national analysis. There is only one exception, where we find in New England there is no asymmetry in price transmission of private label milk. Some regions, like Mountain-Plains, Western, and Southeast, even have reversed asymmetric transmissions where the falling farm price response is greater than the rising farm price response.

In terms of the magnitude of asymmetry, private labels generally have less asymmetry in New England, Mid-Atlantic and Midwest while for others, the asymmetry is more severe. Especially for the private label milk in the Southwest where the difference between sum of rising farm prices and sum of falling farm prices is much bigger than the other two. For regional brands, the asymmetry in price transmission is greatest in the Midwest and Southeast with differences of 0.401 and -0.445. For national brands, the serious asymmetric price transmission happens only in New England and Mid-Atlantic. Thus, we can conclude that private labels, national brands and regional brands all have a heterogeneous effect on price transmission asymmetry, but the impact of private label on farm-retail price transmission asymmetry varies across regions.

5. Conclusion

The asymmetric farm-retail transmission has been well documented in the general fluid milk market. However, little attention has been given to the possible heterogeneous cost pass-through process of private labels. Given the leading role of private labels in the fluid milk market, it is of special interest to focus on its possible heterogeneous effects on farm-retail price transmission. In this paper, we examine the heterogeneous effects of private label and branded product on price transmission asymmetry in the fluid milk market. We incorporate the Houck (1977) procedure to specify and estimate the farm-retail pass-through, which segments the farm prices into increasing and decreasing phases separately. To capture the heterogeneous effects of brand types on price transmission, we include interaction terms of brand type dummies with increasing and decreasing changes in farm prices and then test the asymmetry in farm-retail pass-through for different brand types.

Our results indicate that private label and branded milk all show asymmetry in price transmission. However, brand types affect the magnitudes of the asymmetry and private label milk presents the lowest asymmetry in price transmission, compared with national and regional branded milk. One possible explanation is that retail chains have a greater ability to affect prices of their own private label products through integrated distribution channels and thus impose a strong mitigation power of the asymmetry in farm-retail price transmission.

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Figure 1. Monthly Average Retail price and Class I Price of Whole Milk by Brand Types

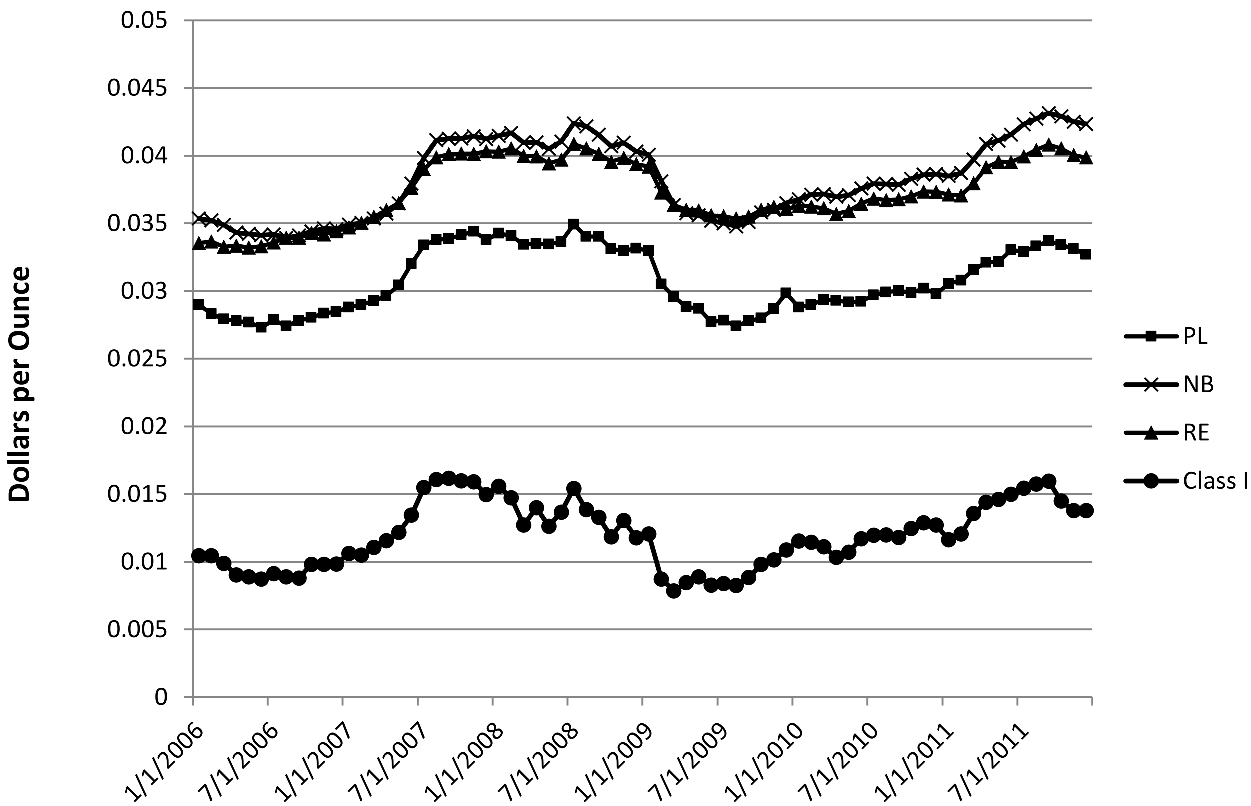

Table 1: Descriptive Statistics of Retail Prices by Milk Brand Types, Fat Contents and Container Sizes

Retail Price	Mean	Std. Dev.	Min	Max
All Types	0.036	0.010	0.010	0.063
Unit price by brand type ($/ounce)				
National Brand	0.038	0.010	0.012	0.063
Regional Brand	0.036	0.010	0.010	0.062
Private Label	0.030	0.009	0.012	0.059
Unit price by fat content ($/ounce)				
Fat-free	0.036	0.011	0.012	0.062
1-percent	0.034	0.010	0.012	0.062
2-percent	0.037	0.010	0.012	0.063
Whole milk	0.037	0.010	0.010	0.063
Unit price by container size ($/ounce)				
32 ounce	0.045	0.008	0.023	0.063
64 ounce	0.038	0.009	0.012	0.062
128 ounce	0.029	0.007	0.010	0.057

Table 2: Descriptive Statistics of Class I Milk Price by Fat Contents

	Mean	Std. Dev.	Min	Max
Class I Price				
All Products ($/ounce)	0.010	0.003	0.005	0.017
Unit price by fat content ($/ounce)				
Fat-free	0.009	0.002	0.005	0.014
1-percent	0.010	0.002	0.006	0.015
2-percent	0.011	0.002	0.006	0.016
Whole milk	0.012	0.002	0.007	0.017

Table 3. Average Retail Price and Class I Price by Brand Types and Regions

	Retail Price				Class I Price
	All Brands	National Brands	Regional Brands	Private labels	
New England	0.038	0.039	0.039	0.028	0.011
Mid-Atlantic	0.036	0.037	0.033	0.033	0.010
Midwest	0.034	0.036	0.037	0.025	0.010
Mountain-Plains	0.034	0.036	0.032	0.027	0.010
Western	0.036	0.038	0.041	0.029	0.010
Southeast	0.039	0.042	0.037	0.032	0.011
Southwest	0.037	0.039	0.025	0.030	0.011

Table 4. Descriptive Statistics for Other Control Variables

Variable	Mean	Std. Dev.	Min	Max
Electricity (Index)	176.36	10.47	158.20	195.80
Plastic (Index)	175.02	8.39	164.20	191.60
Weekly Wage ($)	405.45	63.45	253.00	586.00
Yearly Consumer Expenditure ($/per capita)	32674.89	4292.93	23795.00	45845.00
Retail Concentration (%)	70.16	11.02	43.67	98.80

Table 5. Estimation of Effects of different Brand Types on Farm to Retail Price Transmission

		Coef.	Std. Err.	T
Rising Farm Price				
Current	$\pi_{1,0}$	1.11***[2]	0.05	21.96
One Month Lag	$\pi_{1,1}$	-0.05	0.09	-0.59
Two Month Lag	$\pi_{1,2}$	-0.04	0.05	-0.65
Falling Farm Price				
Current	$\pi_{2,0}$	0.06	0.04	1.49
One Month Lag	$\pi_{2,1}$	0.26***	0.07	3.81
Two Month Lag	$\pi_{2,2}$	0.61***	0.04	14.61
Rising Farm Price × National Brand				
Current	$\pi_{3,0}$	-0.22***	0.06	-3.81
One Month Lag	$\pi_{3,1}$	0.20	0.10	1.89
Two Month Lag	$\pi_{3,2}$	0.16**	0.06	2.51
Falling Farm Price × National Brand				
Current	$\pi_{4,0}$	0.05	0.05	1.00
One Month Lag	$\pi_{4,1}$	0.07	0.08	0.81
Two Month Lag	$\pi_{4,2}$	-0.08	0.05	-1.51
Rising Farm Price × Regional Brand				
Current	$\pi_{5,0}$	0.22**	0.09	2.32
One Month Lag	$\pi_{5,1}$	0.12	0.16	0.74
Two Month Lag	$\pi_{5,2}$	-0.36***	0.10	-3.59
Falling Farm Price × Regional Brand				
Current	$\pi_{6,0}$	-0.17**	0.08	-2.03
One Month Lag	$\pi_{6,1}$	-0.02	0.13	-0.17
Two Month Lag	$\pi_{6,2}$	0.09	0.08	1.09
Other				
Trend	π_0	-8.30E-05***	3.6E-06	-23.31
Plastic	β_1	1.34E-04***	4E-06	33.87
Electricity	β_2	2.10E-06	2.8E-06	0.74
Wages	β_3	5.66E-06***	6.2E-07	9.08
Cost of living	β_4	-4.63E-08***	1.3E-08	-3.51
Retail concentration	β_5	-1.05E-05**	4.7E-06	-2.25
Whole Milk	$\beta_{6,1}$	-4.89E-04***	2.8E-05	-17.46
Fat-free	$\beta_{6,2}$	3.52E-04***	2.9E-05	12.31
1%	$\beta_{6,3}$	2.94E-04***	3E-05	9.67
32 Ounces	$\beta_{7,1}$	1.97E-03***	3.5E-05	57.06
64 Ounces	$\beta_{7,2}$	1.28E-03***	2.2E-05	59.64
R-squared			0.47	
Obs			163,440	

[2] *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

Table 6. Hypothesis Tests of Asymmetry in Farm to Retail Price Transmission with Different Brand Types

		Private Labels		National Brands		Regional Brands	
		Coef.	P-value	Coef.	P-value	Coef.	P-value
Short Term							
	Current Period						
	Rising Farm Price	1.113	0.00	0.888	0.00	1.328	0.00
	Falling Farm Price	0.065		0.116		-0.106	
	One Month Lag						
	Rising Farm Price	-0.051	0.02	0.145	0.05	0.070	0.46
	Falling Farm Price	0.256		0.322		0.234	
	Two Month Lag						
	Rising Farm Price	-0.035	0.00	0.127	0.00	-0.398	0.00
	Falling Farm Price	0.611		0.536		0.700	
Long Term							
	Sum of Rising Farm Price	1.026	0.00	1.160	0.00	1.000	0.00
	Sum of Falling Farm Price	0.932		0.973		0.828	
	Difference	0.094		0.186		0.173	

Table 7. Elasticity of Price Transmission for Different Brands

		Private Labels	National Brands	Regional Brands
Short Run	Rising Farm Price	0.326	0.261	0.390
	Falling Farm Price	0.018	0.032	0.029
Long Run	Rising Farm Price	0.301	0.340	0.294
	Falling Farm Price	0.255	0.267	0.227

Table 8. Hypothesis Tests of Heterogeneous Magnitudes of the Price Transmission Asymmetry for Different Brands

	Private Labels	National Brands	Private Labels	Regional Brands	National Brands	Regional Brands
Difference Between Sum of Rising Farm Price and Sum of Falling Farm Price	0.094	0.186	0.094	0.173	0.186	0.173
P-value	0.000		0.000		0.001	

Table 9. Estimation and Hypothesis Tests of the Long-Run Price Transmission Asymmetry for Different Brands across Regions

		Private Labels			National Brands			Regional Brands		
		Coef.	Diff.	P-value	Coef.	Diff	P-value	Coef.	diff	P-value
New England	Sum of Rising Farm Price	0.945	0.018	0.46	1.059	0.103	0.00	0.915	0.098	0.00
	Sum of Falling Farm Price	0.926			0.956			0.817		
Mid-Atlantic	Sum of Rising Farm Price	1.156	0.207	0.00	1.198	0.245	0.00	1.124	0.218	0.00
	Sum of Falling Farm Price	0.948			0.953			0.905		
Midwest	Sum of Rising Farm Price	1.097	0.271	0.00	1.154	0.331	0.00	1.190	0.401	0.00
	Sum of Falling Farm Price	0.826			0.823			0.789		
Mountain-Plains	Sum of Rising Farm Price	0.404	-0.320	0.00	0.650	-0.262	0.00	0.943	-0.245	0.00
	Sum of Falling Farm Price	0.724			0.911			1.188		
Western	Sum of Rising Farm Price	1.034	-0.128	0.00	1.130	-0.067	0.04	1.138	-0.068	0.05
	Sum of Falling Farm Price	1.162			1.197			1.207		
Southeast	Sum of Rising Farm Price	0.915	-0.321	0.00	1.178	-0.122	0.00	0.610	-0.445	0.00
	Sum of Falling Farm Price	1.237			1.300			1.055		
Southwest	Sum of Rising Farm Price	1.025	0.380	0.00	1.148	0.356	0.00	0.620	0.216	0.00
	Sum of Falling Farm Price	0.646			0.792			0.404		
National (as shown in Table 6)	Sum of Rising Farm Price	1.026	0.094	0.00	1.160	0.186	0.00	1.000	0.173	0.00
	Sum of Falling Farm Price	0.932			0.973			0.828		