The Impact of Price Regulations on Farm-Retail Price Transmission: The Case of Fluid Milk

Adam N. Rabinowitz
Assistant Research Professor
Department of Agricultural and Resource Economics
University of Connecticut
adam.rabinowitz@uconn.edu

Yizao Liu
Assistant Professor
Department of Agricultural and Resource Economics
University of Connecticut
yizao.liu@uconn.edu

Xuan Chen
Graduate Research Assistant
Department of Agricultural and Resource Economics
University of Connecticut
xuan.2.chen@uconn.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association (SAEA) Annual Meeting, San Antonio, Texas, February, 6-9, 2016

The Impact of Price Regulations on Farm-Retail Price Transmission: The Case of Fluid Milk

Abstract

This article analyzes the impact of federal and state milk pricing regulations on cost past through in the U.S. fluid milk market. Producer pricing in the fluid milk market is regulated by federal and/or state milk marketing regulations while the retailer price is influenced in some geographic locations by state regulations ranging from minimum to maximum pricing policies. The regulation either aims to support local dairy farmers or protect consumers from price gouging, either of which could also affect the response of retail milk prices to farm price changes. We use monthly state-level retail milk pricing data across the US from 2006 to 2011 to estimate the nonreversible function of farm-retail price transmission using the Houck (1977) procedure. Specifically, our model includes increasing and decreasing accumulated farm price changes with an expansion to include interaction terms of pricing regulations. This modeling approach allows us to explore the influences of price regulations on the farm-retail price transmission. The results indicate that pricing regulations have a significant influence on price transmission, regardless of the type of regulation. Minimum price laws have the strongest mitigation power of the asymmetries in farm-retail price transmission, while a maximum price law has an amplifying effect.

Keywords: asymmetry, dairy policy, price transmission, retail pricing

[JEL Classification: Q11, Q13, Q18]

1. Introduction

Over the past few decades there has been much literature that has focused on the relationship between changes in the farm price of an agricultural product and the changes in the related retail price. This mechanism, known as farm-retail price transmission, has been of much interest due to the typical asymmetries that exist. For example, it has been found in the case of milk that retail milk prices respond to farm price increases more rapidly than they do to farm price decreases (Kinnucan and Forker 1987; Lass et al 2005; Capps and Sherwell 2007; a few others). One of the major concerns of asymmetric price responses comes from its effect on the market and consumer demand. In particular, retailers are primed to earn excess profits in cases where retail prices lag in response to farm price decreases. Farmers, however, do not have that same benefit when retailers increase prices more rapidly than farm price increases. This scenario has been repeatedly documented in fluid milk and is a cause for concern with milk consumption on a steady decline in the United States, decreasing about 37 percent since 1970 (Bentley, 2014). Furthermore, the number of dairy farms has been decreasing during the last half a century, falling almost 90 percent since 1970, yielding further interest in studying mechanisms that impact the dairy industry.

Ultimately the asymmetries in the farm-retail price transmission raise concerns about the retail milk prices faced by consumers. While retailers control the final price paid by consumers, government policies are a contributing factors that influence the retailers' decision including the degree of price transmission and pricing levels. In the case of fluid milk, retail price policies exist(ed) at the state level or federal level. One such policy implemented at the federal level, the Northeast Dairy Compact, was a regional policy that existed from 1996 to 2001 and set a price floor for the farm price but also was shown to have impacted retail prices. Lass et al (2005) find that during the Compact period, farm-retail price transmission increased more than the pre-Compact period, providing support for the argument that the Compact represented the potential for tacit collusion in retail pricing behavior. The Dairy Compact, however, has not been in existence since September 2001 but other government policies have

existed prior and subsequently. In New York State (NYS), Bolotova and Novakovic (2012) study the effect of the NYS Milk Price Gouging (MPG) Law on the farm-retail price transmission of milk. The New York law established a retail price of 200% of the Class I farm price and during the period prior to October 2008 the threshold price was announced to retailers and the public. Their research, consistent with Romain, Doyon, and Frigon (2002), finds that the application of the law (i.e. publishing threshold prices) resulted in more symmetric price transmission compared to the period before the law was enacted, providing further evidence of tacit collusion present in the face of government policy interacting with market forces. The NYS MPG Law ultimately underwent changes in the application of the law in October 2008, resulting in lower prices and indications of the potential for decreased coordination as a result of less regulatory action (Rabinowitz and Liu 2014).

While there are documented impacts of government policies impacting the farm-retail price transmission and retail pricing of milk, the existing literature has focused on only select policies or specific geographic areas without regard to government influence (Capps and Sherwell 2007). Government policy, however, plays a major role in the milk sector at both federal and state levels throughout the country and when considering farm-retail price transmission, consideration needs to be given to the various government factors that influence these different levels of the supply chain. At the farm level there is the Federal Milk Marketing Program that exists in a large portion of the U.S. in addition to a variety of state laws that mandate minimum prices. At the retail level there are different types of state laws that regulate minimum and maximum prices of fluid milk. Other than research on the Dairy Compact and the NYS MPG Law there is a gap in the literature with respect to the variety of other state milk pricing policies. This research attempts to fill that gap and provides needed evidence of the impact of state pricing policies with respect to farm-retail price transmission of fluid milk.

Additionally, the breadth of geographic coverage of previous milk farm-retail price transmission literature is limited to roughly a dozen major cities in the U.S. This is primarily the case because researches rely on the U.S. Department of Agriculture (USDA) Agricultural Marketing Service (AMS) retail price reports. These price reports provide monthly retail prices for whole milk based on a survey conducted in one outlet of the largest and second largest food chain and the largest convenience store chain during one day of the month in selected major

cities. For our analysis we use data from 48 states of prices paid by consumers during the entire monthly period.

Our contribution to the literature is therefore two-fold. Primarily we are interested in the effects of state retail pricing policies for which we include the 48 contiguous states in our analysis expanding the geographic scope of the literature. Secondarily we use a dataset previously disregarded for estimating farm-retail price transmission in the fluid milk market that is also more comprehensive in determining monthly average retail prices. Therefore, we fill a void in the literature that can have implications on state and federal milk policies as well as farmer and consumer social welfare.

2. Milk Pricing Laws

Three types of laws exist within the United States (U.S.) that influence the retail price of milk. The first type of law restricts the price of milk (often along with other selected goods) from being sold at retail below cost. We refer to this as a "general milk law". The second type of law is a minimum pricing law that allows state regulators to set a specific minimum retail price for milk, herein referred to as the "milk minimum law". The third type of law, which we refer to as a "milk maximum law" allows regulators to set a maximum retail price.

Table 2 provides a list of different milk pricing laws and the corresponding states in the U.S. Regulatory information was collected from a variety of sources including state statutes from respective states.[1] Overall, there are 30 states implementing some form of milk pricing laws, of which 20 are classified as a general milk law, nine are a minimum price law, and only one state, New York, stipulates a maximum price law. In addition, there are 18 states in the U.S. without any type of retail pricing law in the fluid milk market. During our sample period, we do not observe a state switching between different types of milk pricing laws, however, New York State did change the application of the milk pricing gouging law in November 2008. Even with the change in the enforcement of the law it still remains a maximum price law

[1] Specific citations available upon request.

designed to protect consumers from high prices, thus no shifting in categorization of laws is necessary.

3. Model Specification

To estimate the effect of milk pricing regulations on the asymmetric adjustment of retail prices to the changes in farm prices (i.e., Class I milk price), we use the Houck (1977) procedure to specify and estimate an econometric model of farm-retail price transmission. 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. The approach has been used extensively in previous empirical studies when examining asymmetry in farm-retail transmission in the U.S. fluid milk industry (Kinnucan and Forker, 1987; Lass, 2005; Lass et al., 2001; Bolotova and Novakovic, 2012). While other specifications for farm-retail price transmission exist, such as the von Cramon-Taubadel and Loy error correction model, Capps, and Sherwell (2007) have shown that the two approaches produces nearly identical results, thus we have chosen to use the Houck procedure for this analysis.

In this analysis, a single milk product is defined as a combination of butterfat content and container size. For example, a one-gallon bottle of whole milk and a half-gallon bottle of whole milk are considered as two different products. The empirical specification is then given by the following equation:

$$R^*_{ijt} = \pi_0 Trend_t + \sum_{k=0}^{2} \pi_{1,k} FR^*_{ij,t-k} + \sum_{k=0}^{2} \pi_{2,k} FF^*_{ij,t-k} + \sum_{k=0}^{2} \pi_{3,k} FR^*_{ij,t-k} * Law_{jt} + \sum_{k=0}^{2} \pi_{4,k} FF^*_{ij,t-k} * Law_{jt} + \beta_1 Plastic^*_{jt} + \beta_2 Electricity^*_{jt} + \beta_3 Wages^*_{jt} + \beta_4 living^*_{jt} + \sum_{l=0}^{3} \beta_{5,l} Type_i + \sum_{l=0}^{2} \beta_{6,l} Size_i + \varepsilon_{ijt} \quad (1)$$

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 the 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).[2]

Specifically, to capture the effect of milk pricing regulations on the asymmetries of farm-retail price transmission, our model includes the interaction terms of regulations and accumulated farm price changes of two directions. Law_{jt} is a dummy variable which equals to 1 if a state *j* implements any type of retail price regulations in the fluid milk market at time *t*. Interaction terms are constructed using Law_{jt} and farm price rising phase (FR^*_{ijt}) and the farm price falling phase (FF^*_{ijt}), respectively.

Since processing costs and retailing costs are also major components of costs that affect retail prices, we include price indices of plastic products, electricity and retail wages, which are the main inputs in milk bottling, storage and retailing. They are used as proxies for marketing costs to control for shifts in processing and retailing costs. $Living^*_{jt}$ is the total personal consumption expenditures per capita of state *j* at time *t* which captures the persistent pricing differences across states. $Plastic^*_{jt}$, $Electricity^*_{jt}$, $Wages^*_{jt}$, and $Living^*_{jt}$ 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 size 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 containers as the base variable.

To determine the existence of the asymmetry in farm-retail price transmission, hypothesis tests for both short term transmission and long term transmission are conducted. Specifically, we test the individual and aggregated parameters of the farm price rising phase and farm price falling phase:

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

$$H_o: \pi_{1,k} = \pi_{2,k} \qquad \text{for lags } k = 0,1,2;$$

$$\text{and} \qquad H_o: \sum_{k=0}^{2} \pi_{1,k} = \sum_{k=0}^{2} \pi_{2,k} \qquad \text{for lags } k = 0,1,2$$

In the first hypotheses, we test whether rates of farm-retail price adjustment are the same for rising versus falling farm prices, i.e., the short-run asymmetric price transmission. The second hypotheses uses all lagged effects to test the cumulative long-term effect of equivalent farm prices increases and decreases.

To examine the effect of pricing regulations on the speed of price transmission, we first conduct two similar hypothesis tests of the adjustment speed of the farm price falling phase and farm price rising phase with milk price regulation.

$$H_o: \pi_{1,k} + \pi_{3,k} = \pi_{2,k} + \pi_{4,k} \qquad \text{for lags } k = 0,1,2;$$

$$\text{and} \qquad H_o: \sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{3,k} = \sum_{k=0}^{2} \pi_{2,k} + \sum_{k=0}^{2} \pi_{4,k} \qquad \text{for lags } k = 0,1,2$$

The first hypotheses tests the short-run asymmetric farm-retail price transmission with the effect of pricing regulations in the fluid milk market and the second set tests the long-run effect.

Further, we also test the following hypotheses:

$$H_o: \left(\sum_{k=0}^{2} \pi_{1,k} + \sum_{k=0}^{2} \pi_{3,k}\right) - \left(\sum_{k=0}^{2} \pi_{2,i} + \sum_{k=0}^{2} \pi_{4,i}\right) = \left(\sum_{k=0}^{2} \pi_{1,k} - \sum_{k=0}^{2} \pi_{2,k}\right)$$

$$H_a: \left(\sum_{k=0}^{2} \pi_{1,i} + \sum_{k=0}^{2} \pi_{3,i}\right) - \left(\sum_{k=0}^{2} \pi_{2,i} + \sum_{k=0}^{2} \pi_{4,i}\right) > or < \left(\sum_{k=0}^{2} \pi_{1,k} - \sum_{k=0}^{2} \pi_{2,k}\right)$$

$$\text{for lags } k = 0,1,2$$

If we confirm the existence of asymmetric price transmission, we also test whether the differences between the effect of cumulative farm pricing increase and decreases are the same with or without any pricing regulations. In other words, we test whether the pricing regulations have a mitigating or amplifying effect on the asymmetry of price transmission.

4. Data

We use Nielsen Homescan data 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 records and pricing information from grocery stores, drug stores, convenience stores, and supermarkets in all 48 states. In this paper, we restrict our analysis to private label fluid milk for two main reasons. First, in the fluid milk market, private-label accounts for around 60% of the market share, thus representing a large majority of household purchases. Second, by using private label milk, we can ignore the impact

of branding and other marketing strategies on retail pricing and focus more directly on the farm-retail price transmission. We also restrict our analysis to milk sold in the supermarket channel only because this accounts for a majority of the retail milk and we wish to eliminate potential differences in pricing strategies across retail channels. The retail prices for all private label fluid milk purchased in supermarkets are aggregated to monthly state-level observations.

Table 2 reports the summary statistics for all private label milk in the 48 states. The average unit retail price for all types of milk and all types of container sizes is $0.03 per ounce. When we break down the average retail prices by milk type, there are slight variations across milk with different fat content, ranging from $0.027 per ounce for fat-free milk to $0.031 per ounce for whole milk. In terms of different container sizes, the average unit price of 32-ounce containers is $0.043, while it is $0.023 per ounce for a 128-ounce package.

We use Class I milk prices for each state to measure the farm price of fluid milk. The Class I price represents the cost of farm milk as an input for the fluid milk processing industry and is collected from the USDA AMS Dairy Program. Class I milk prices are subject to county differential adjustment and are then are aggregated to state-level observations. Unfortunately, not all counties or states in the U.S. are covered by the Federal Milk Marketing Order (FMMO) system. In many of these non-FMMO areas we do not observe the Class I milk prices directly. Thus in non-FMMO areas we follow the same process as FMMO areas, using the county differential adjusted Class I milk price as a proxy for farm prices. Adjustments are computed for differences in butterfat content using the USDA AMS formula for converting Class I (3.5% butterfat) prices to the appropriate consumer butterfat content (fat-free, 1%, 2%, and whole) and container size (quart, half-gallon, and gallon).

The summary statistics for Class I prices are also presented in Table 2. The average Class I price for all types of milk and all types of container sizes is $0.01 per ounce. Whole milk, with the greatest amount of butterfat (3.25%) has the highest mean farm price at $0.012 per ounce. In addition, the standard deviation of farm prices is smaller than that of retail prices, suggesting differing farm-retail pricing behaviors. Figure 1 presents the retail and Class I milk prices per gallon of whole milk for January 2006 through December 2011. Due to the global economic recession, both retail and Class I prices declined sharply in late 2008 and early 2009, and recovered slowly starting late 2009. Further, there are periods showing the “stickiness” of

prices. For example, during the first two quarters in 2008, the Class I prices experienced dramatic fluctuations while retail price only react to the increases in Class I prices. During the first quarter in 2010, the retail price remain stable while Class I price was dropping.

Table 3 presents summary statistics of retail and Class I prices by different pricing law types. Overall, retail prices in states with any pricing law are higher than those in states without laws. Among states with laws, it is not surprising that those states with a minimum pricing law has the highest average retail prices, followed by states with a maximum pricing law and a general milk law. By design of the Class I price structure, these prices are very similar across states with differentiation based on the Federal Milk Marketing Order regulations. A greater variation in retail prices with a more constant farm price implies that the rate of farm-retail price transmission may differ across states and type of regulation.

Other data for estimation is collected from the U.S. Bureau of Labor and Statistics (BLS) and U.S. Bureau of Economic Analysis (BEA). Table 4 provides the summary statistics of these data. Monthly producer price indices of plastic products and electricity are included in the estimation. Weekly wages paid by grocery stores based on the Quarterly Census of Employment and Wages is also included in our dataset. In addition, we include the per capita total personal consumption expenditure by state to control for cost of living differences across states.

5. Empirical Results

5.1 Main Results

In this section, we present the estimation results from the main model specified in Equation 1. We first conduct the estimation of asymmetry in farm-retail price among all states in the sample targeting on the effect of the existence of the regulation regardless of the specific regulation type. As shown in Table 5, for states without any law, the farm price rising in the current period ($\pi_{1,0}$) has a significant impact on retail price changes: a $1 increase in the farm price will lead to a $1.16 increase in current retail prices. In terms of lag effects, the estimated coefficients for one-period ($\pi_{1,1}$) are not statistically significant while the two-period ($\pi_{1,2}$) are significant, pulling down the retail price $0.18 after two months with a $1 increase in current

farm price. These results suggest that the retail price is positively influenced by the current period rising farm prices, even though there is a small correction with the two-period lag effect in states without any pricing laws.

The response to falling farm prices, on the other hand, is of a much smaller magnitude. In fact, the greatest impact of falling farm prices occurs at a two-period lag ($\pi_{2,2}$), where a $1 decline in farm price leads to a $0.81 decrease in retail price, while the current period effect is a $0.19 increase in the retail price. During the intermediate period of a one-month lag, the retail price drops by $0.21 in response to a $1 decline in the farm price. This implies that when farm prices fall, the retailer initially increases prices but then responses on month later with a reduction in price slightly more than the previous month increase, effectively keeping the retail price stable. It isn't until two months later that a significant correction in retail prices occurs. One possible explanation for this behavior is that in states where retail milk price laws do not exist there is less attention on the fluctuating farm price and in turn either a delayed response or a direct reluctance on the part of retailers to adjust the retail price in real time with declining farm prices.

The parameters of special interest in this study are the interaction terms of *Law* and farm price changes, which are reported in the second panel of Table 5. The interaction term between the Law variable and the current and one-month lag are not statistically significantly different from zero, thus the existence of a law during rising farm prices has no additional impact on retail pricing. However, there is a two-period lag effect in farm price rising ($\pi_{3,2}$) that is significant and shows that retail prices ultimately increase in states with milk pricing laws. The existence of a milk pricing law also has a significant impact of current and two-period lag of farm price falling. In particular, states with law will fall more rapidly in the current period to falling farm prices falling, relative to states without a law. However, there is a partial rebound effect two months later that mitigates a large portion of the price drop.

To illustrate a clearer comparison of the total effects, we calculate the full retail price responses of farm price rising ($\pi_{1,k} + \pi_{3,k}, k = 0,1,2$) and falling ($\pi_{2,k} + \pi_{3,k}, k = 0,1,2$) in states with laws, as shown in the second column of Table 6, and without laws, in column five of Table 6. An increasing farm price of $1 in the current period leads to a $1.03 increase in retail price, which is a smaller increase than that of states without a pricing law, although still greater than

1. Similarly, the response of retail prices to a $1 decrease in farm price is also less in states with a milk price law. Hypothesis tests are also conducted to determine whether the single period rising effects are different from the single period falling effects in states with milk pricing laws and the results are also presented in Table 6. The p-value of 0.00 indicates that the current period rising coefficient is statistically greater than the current period falling coefficient, while the two-period lag rising coefficient is statistically smaller than the two-period lag falling coefficient. The one-period lag coefficients, however, are not statistically different. Therefore, in the short run, there is empirical evidence that the adjustment to rising farm milk prices is more rapid than the adjustment to falling farm prices in states with milk pricing laws. The hypothesis tests for states with no law are also estimated with the results also presented in Table 6.

In addition to independent current and lagged responses, we also consider the net effect after adjustments to both rising and falling farm prices in the long run. Specifically, we compare and test the sum of the current, one-period, and two-period lag rising coefficient and the sum of the three falling coefficients. As shown in the second panel of Table 6, there are substantial and statistically significant differences between the two sums, which implies that in the long run, the time-path for adjustment to rising farm prices is more rapid than the time-path adjustment to falling farm prices. In other words, we observe asymmetric farm-retail price transmission in states with milk pricing laws. The same analysis is also conducted for states with no milk pricing law and we find a similar statistically significant asymmetric price transmission.

Given that there exists asymmetric farm-retail price transmissions in states with or without milk pricing law, it is of interest to determine if there are any differences in asymmetries. For instance, we can analyze how the law affects the magnitude of the asymmetry of adjustment. In other words, will the law amplify or mitigate the asymmetry in farm-retail price transmission? We calculate the difference between the sum of farm price rising and the sum of farm price falling for states with and without milk pricing law. For states with a law, the difference is 0.14, which is smaller than that of states without a law. Furthermore, the F test shows these two differences are significantly different with a *p-value* equal to 0.002.

Therefore, the milk pricing laws has a mitigation power of the asymmetric farm-retail price transmission.

Finally, estimation results for all other parameters are presented in Table 5. Overall, there is a declining trend in fluid milk retail price changes. As expected, plastic prices, retail wages and the cost of living all have a positive and significant impact on retail price changes.

5.2 Impacts of Different Types of Regulations

While we find the existence of any type of milk pricing law as having a mitigating effect on the asymmetries of farm-retail price transmission, there do exist three different categories of laws that may have further differentiation. Thus we separate the law variable into more specific regulation types to isolate the individual impacts of different regulations on farm-retail price transmission.

With respect to individual regulations (see Table 7), the general milk law does not have a statistically significant effect in the current or two lagged periods during either rising farm prices or falling farm price. The milk minimum law has a statistically significant impact on the current retail price while maximum law does not. The negative sign indicates that the milk minimum law slows down the growth speed of the retail prices as a response to rising farm prices in the current period. For example, with a $1 increase in the farm price, retail price in the current period will decrease by $0.28 under the minimum law compared to states with no law. As for lag effects, the two-period lag shows the significance in both minimum and maximum law states with the maximum law having a greater impact. That is, with a $1 increase in the farm price, a maximum law will increase retail price by $0.64 (1.10-0.46) more than minimum law states. Neither of these two laws have statistically significant impact in the one-period lag. It is important to note that these comparisons are only of the regulation effect compared to the no regulation effect and are not total responses to changes in the farm price.

With respect to falling farm prices, the affected period and the direction of adjustment in the current month (or one-period or two-period lag) are the same for the milk minimum law and maximum law, although the milk maximum law has a greater magnitude of effect. When the farm price drops $1, the maximum law states adjust $1.24 (1.71-0.47) more in the current

period and -$0.83 (-1.28-(-0.45)) more in two-month lag, as compared to states with no retail milk pricing laws.

These results of the specific type of retail pricing law indicates that different regulations have differentiated influences on the farm-retail price transmission. But, does it also act on the asymmetric pricing behavior? Hypothesis tests for short-run and long-run are conducted to test the full retail price responses (farm price change effect plus regulation effect) in states under different regulations.

As shown in Table 8, in the current period, the full rising effect is different from the current period full falling effect under all regulation types. Moreover, the retail price adjusts more rapidly with respect to rising than falling of the farm price under both the general milk law and minimum milk law states, while the maximum law results in the opposite effect. As to two-period lag effects for different regulations, both the general milk law and maximum milk law has statistically different and significant coefficients. The one-period lag coefficients, however, are not statistically different for all regulation types. Therefore, in the short run, there is empirical evidence that asymmetric price transmission occurs under different types of retail milk price policies. The hypothesis test results for states with no law also indicates price transmission asymmetry.

We also present in Table 8 the hypothesis test for differences in the long term estimates under different regulations. For all regulation types, the sum of the price rising coefficient is significantly larger than that of the falling farm price coefficient, indicating asymmetries are present under different types of regulations. Thus we can reject our null hypothesis that regulation eliminates asymmetric price transmission. However, different regulation types do have differentiated impacts on the magnitude of asymmetry. Our estimates indicate that the difference between the sum of the farm price rising and the sum of the farm price falling computations are 0.096 and 0.102 for the general milk law and milk minimum law, respectively. Furthermore, the existence of a milk maximum law has difference between the two effects of 0.341. In contrast, we find that states with no law influences retail milk prices have a difference of 0.124. We further show in Table 9 the results of a hypothesis test comparing the difference between the no law results and each specific law result. We find that for each type of law the *p-value* is zero, implying those differences are significantly different with no law states. That

is, the mitigation power of a general milk law and milk minimum law and the amplifying power of a milk maximum law are statistically different from the asymmetric effect of no law.

6. Conclusion

Farm-retail price transmission has been studied over the years in a variety of geographic markets or with respect to impacts of specific government policies. In this study we address a missing void in the literature by estimating farm-retail price transmission across the 48 contiguous states, focused on a three different types of milk price laws affecting retail prices faced by consumers. While the intent of these laws are to benefit the farmer or the consumer, we find that an asymmetry exists between changes in the farm price and changes in the retail price of fluid milk. This is consistent with previous literature, however, we expand on this common finding by providing an understanding of the differing effects of different laws.

With respect to general milk laws, we find differences in long term effects that are less than pass-through rates in states where no milk price laws exist. We find very similar results in states with a minimum milk law, thus reinforcing the idea that minimum retail price milk laws have a mitigating impact on the asymmetries of farm-retail price transmission, however, the asymmetries continue to exist. More significantly, we find that the existence of a milk maximum law creates an amplifying effect of the long term impacts, adding further support to previous literature that has questioned the whether a MPG law elicits tacit collusion among retailers.

7. References

Bentley, J. (2014), Trends in U.S. per capita consumption of dairy products, 1970-2012. Amber Waves, available at http://www.ers.usda.gov/amber-waves/2014-june/trends-in-us-per-capita-consumption-of-dairy-products,-1970-2012.aspx#.VqLJ4NGFPcs

Bolotova, Y.V. and Novakovic, A.M. (2012), The impact of the New York State milk price gouging law on the price transmission process and supermarket pricing strategies in the fluid whole milk market. *Agribusiness*, 28(4): 377-399.

Capps, O. and Sherwell, P. (2007), Alternative approaches in detecting asymmetry in farm-retail price transmission of fluid milk. *Agribusiness*, 23: 313–331.

Houck, J.P. (1977), An approach to specifying and estimating nonreversible functions. *American Journal of Economics*. 59(3):570-572.

Kinnucan, H.W. and Forker, O.D. (1987), Asymmetry in farm-retail price transmission for major dairy products. *American Journal of Agricultural Economics*, 69(2):285-292.

Lass, D.A., Adanu, M. and Allen, P.G. (2001), Impacts of the Northeast Dairy Compact on New England retail prices. *Agricultural and Resource Economics,* 30(1):83-92.

Lass, D. A. (2005). Asymmetric response of retail milk prices in the northeast revisited. *Agribusiness*, 21(4), 493-508.

Rabinowitz, A., and Yizao, L. (2014), The impact of regulatory change on retail pricing: the New York State milk price gouging law. *Agricultural and Resource Economics Review*, 43(1): 178-192

Romain, R., Doyon, M. and Frigon, M. (2002), Effects of state regulations on marketing margins and price transmission asymmetry: Evidence from the New York City and upstate New York fluid milk markets. *Agribusiness*, 18(3):301-315.

Table 1. States and Regulation Types

General Milk Law	Milk Minimum Law	Milk Maximum Law	No Law
Arkansas	Maine	New York	Alabama
California	Minnesota		Arizona
Colorado	Missouri		Connecticut
Idaho	Nevada		Delaware
Kentucky	North Carolina		Florida
Louisiana	Pennsylvania		Georgia
Maryland	Tennessee		Illinois
Massachusetts	Vermont		Indiana
Mississippi	Virginia		Iowa
Montana			Kansas
Nebraska			Michigan
North Dakota			New Hampshire
Ohio			New Jersey
Oklahoma			New Mexico
Rhode Island			Oregon
South Carolina			South Dakota
Utah			Texas
West Virginia			Washington
Wisconsin			
Wyoming			
Count: 20	9	1	18

Table 2: Descriptive Statistics of Prices by Milk Types and Package Sizes

	Mean	Std. Dev.	Min	Max
Retail Price				
All Products	0.030	0.009	0.012	0.059
Unit price by type ($/ounce)				
Fat-free	0.027	0.007	0.012	0.053
1-percent	0.030	0.009	0.012	0.056
2-percent	0.030	0.009	0.012	0.059
While milk	0.031	0.009	0.012	0.058
Unit price by container size ($/ounce)				
32 ounce package	0.043	0.007	0.023	0.058
64 ounce package	0.031	0.007	0.015	0.059
128 ounce package	0.023	0.004	0.012	0.035
Class I Price				
All Products ($/ounce)	0.010	0.003	0.005	0.017
Unit price by type ($/ounce)				
Fat-free	0.010	0.002	0.006	0.015
1-percent	0.011	0.002	0.006	0.016
2-percent	0.009	0.002	0.005	0.014
While milk	0.012	0.002	0.007	0.017
Unit price by container size ($/ounce)				
32 ounce package	0.011	0.003	0.005	0.017
64 ounce package	0.010	0.003	0.005	0.017
128 ounce package	0.010	0.003	0.005	0.017

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

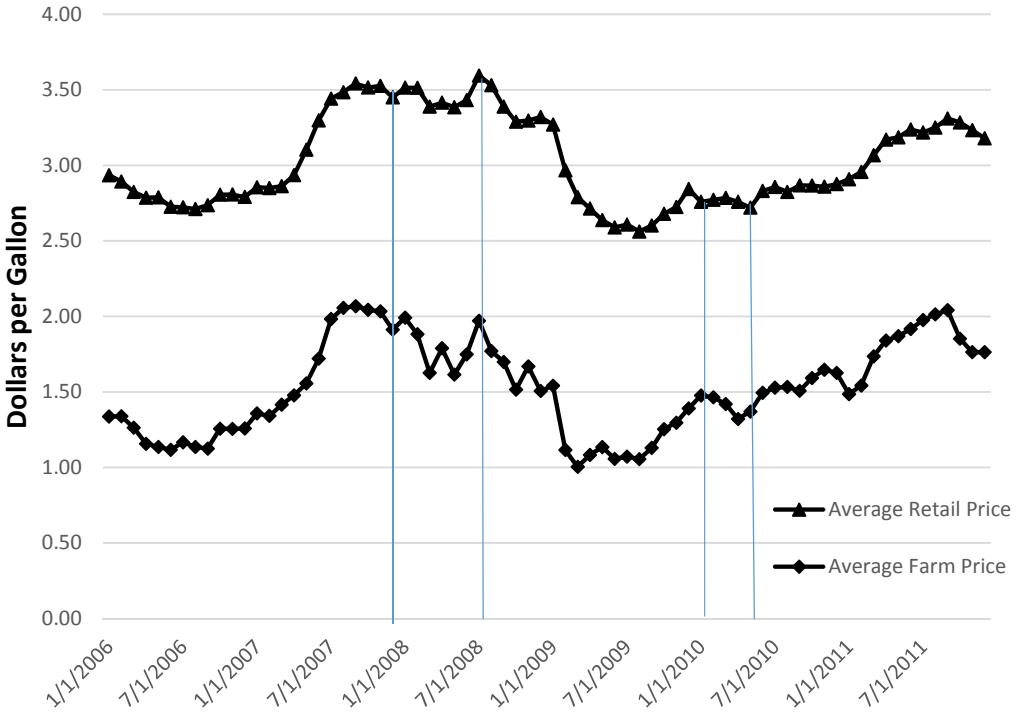

Table 3. Average Retail Price and Class I Price by Regulation Types

	Retail Price ($/ounce)		Class I Price ($/ounce)	
	Mean	Std.Dev.	Mean	Std.Dev.
No law	0.0287	0.0089	0.0104	0.0026
Any Law	0.0301	0.0086	0.0103	0.0025
General Milk Law	0.0292	0.0089	0.0103	0.0025
Milk Minimum Law	0.0316	0.0083	0.0103	0.0025
Milk Maximum Law	0.0306	0.0062	0.0107	0.0025

Table 4. Descriptive Statistics for Other Cost Shifts

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

Table 5. Estimation of Regulation Effect on Farm to Retail Price Transmission

		Coef.	Std. Err.	t
Farm Price Rising				
Current	$\pi_{1,0}$	1.16*	0.09	13.56
One Month Lag	$\pi_{1,1}$	0.01	0.14	0.07
Two Month Lag	$\pi_{1,2}$	-0.18*	0.09	-2.02
Farm Price Falling				
Current	$\pi_{2,0}$	-0.19*	0.07	-2.75
One Month Lag	$\pi_{2,1}$	0.21*	0.11	1.96
Two Month Lag	$\pi_{2,2}$	0.81*	0.07	12.13
Farm Price Rising × Law				
Current	$\pi_{3,0}$	-0.13	0.10	-1.27
One Month Lag	$\pi_{3,1}$	-0.05	0.18	-0.28
Two Month Lag	$\pi_{3,2}$	0.28*	0.11	2.51
Farm Price Falling × Law				
Current	$\pi_{4,0}$	0.35*	0.09	4.04
One Month Lag	$\pi_{4,1}$	0.05	0.14	0.33
Two Month Lag	$\pi_{4,2}$	-0.28*	0.08	-3.38
Other ($\times 10^3$)				
Trend	π_0	-1.00E-04*	6.55E-06	-15.30
Plastic	β_1	8.70E-05*	7.18E-06	12.12
Electricity	β_2	3.28E-06	5.20E-06	0.63
Wages	β_3	8.89E-06*	1.02E-06	8.73
Cost of living	β_4	2.53E-07*	2.52E-08	10.06
Whole Milk	$\beta_{5,1}$	-9.44E-04*	5.29E-05	-17.84
Fat-free	$\beta_{5,2}$	3.95E-04*	5.47E-05	7.23
1%	$\beta_{5,3}$	-5.64E-04*	5.34E-05	-10.55
32 Ounces	$\beta_{6,1}$	2.45E-03*	8.15E-05	30.03
64 Ounces	$\beta_{6,2}$	1.51E-03*	3.84E-05	39.40
R-squared			0.47	
Obs			31392	

Table 6. Hypothesis Tests of Asymmetry in Farm to Retail Price Transmission with Law or without Law

	Law	F test	p Value	No Law	F test	p Value
Short Term						
Current						
Farm Price Rising	1.03	72.43	0.00	1.16	110.48	0.00
Farm Price Falling	0.16			-0.19		
One Month Lag						
Farm Price Rising	-0.04	2.96	0.09	0.01	0.82	0.36
Farm Price Falling	0.25			0.21		
Two Month Lag						
Farm Price Rising	0.09	17.59	0.00	-0.18	57.84	0.00
Farm Price Falling	0.52			0.81		
Long Term						
Sum of Farm Price Rising	1.08	55.50	0.00	0.98	65.45	0.00
Sum of Farm Price Falling	0.94			0.83		
difference	0.14			0.16		
p for difference		0.002				

Table 7. Estimation of Effects of different Regulation Types on Farm to Retail Price Transmission

		No Law		General Milk Law		Milk Minimum Law		Milk Maximum Law	
Regulation Effects		Coef.	t	Coef.	t	Coef.	t	Coef.	t
	Farm Price Rising								
	Current×Regulation Type	1.18*[3]	13.86	-0.01	-0.13	-0.28*	-2.10	-0.44	-1.87
	One Month Lag×Regulation Type	0.00	-0.02	-0.05	-0.27	-0.06	-0.26	0.04	0.11
	Two Month Lag×Regulation Type	-0.20*	-2.19	0.09	0.77	0.46*	3.13	1.10*	4.34
	Farm Price Falling								
	Current×Regulation Type	-0.18*	-2.67	0.15	1.55	0.47*	3.98	1.71*	8.08
	One Month Lag×Regulation Type	0.22*	2.08	0.00	-0.02	0.13	0.67	0.06	0.19
	Two Month Lag×Regulation Type	0.82*	12.30	-0.09	-1.01	-0.45*	-3.88	-1.28*	-6.26
Others				Coef.	t				
	Trend			-8.38E-05*	-12.83				
	Plastic			9.42E-05*	13.28				
	Electricity			2.00E-06	0.39				
	Wages			7.25E-06*	7.18				
	Cost of living			1.04E-07*	4.19				
	Whole Milk			-9.52E-04*	-18.34				
	Fat-free			3.75E-04*	6.97				
	1%			-6.00E-04*	-11.39				
	32 Ounces			2.27E-03*	28.74				
	64 Ounces			1.51E-03*	39.34				
R-squard				0.4807					
Obs				31392					

[3] No law states are the base, no interaction term applied. It is listed as the comparison for other types of regulations.

Table 8. Hypothesis Tests of Asymmetry in Farm to Retail Price Transmission with Different Regulations

		General Milk Law		Milk Minimum Law		Milk Maximum Law		No law	
		Coef.	p	Coef.	p	Coef.	p	Coef.	p
Short Term									
	Current								
	Farm Price Rising	1.16	0.00	0.89	0.00	0.74	0.03	1.18	0.00
	Farm Price Falling	-0.04		0.29		1.53		-0.18	
	One Month Lag								
	Farm Price Rising	-0.06	0.19	-0.06	0.18	0.04	0.70	0.00	0.30
	Farm Price Falling	0.22		0.35		0.28		0.22	
	Two Month Lag								
	Farm Price Rising	-0.10	0.00	0.27	0.61	0.90	0.00	-0.20	0.00
	Farm Price Falling	0.72		0.36		-0.46		0.82	
Long Term									
	Sum of Farm Price Rising	1.004	0.000	1.099	0.000	1.685	0.000	0.979	0.000
	Sum of Farm Price Falling	0.908		0.997		1.344		0.855	
	difference	0.096		0.102		0.341		0.124	

Table 9. Hypothesis Tests of Effects of Different Regulations on the Price Transmission Asymmetry Magnitude

	Difference Between Sum of Farm Price Rising and Sum of Farm Price Falling	p
No law	0.124	
General Milk Law	0.096	0.000
Milk Minimum Law	0.102	0.000
Milk Maximum Law	0.341	0.000