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MILK PRICE SPREADS: HOW DOES THE PRICE OF RAW MILK RELATE TO ITS RETAIL PRICE?

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Abstract

Are consumers overcharged for milk during periods of raw milk price decline? How do retail prices adjust to changes in raw milk cost among cities and over time? Current issues have made these questions about the spread between raw and retail milk prices very topical. Two situations were examined with linear regression models using ordinary least squares. Reviewing analyses of price levels and price changes for time-series data, and a cross-sectional model of the relationship of price levels across cities, this paper observes the basic factors in the association between raw and retail milk prices. These models suggest the difficulty in making broad-based assertions when there is so much variability in price spreads between regions and individual cities.

Are consumers paying too much for milk? Are processors or retailers securing excessive profits by not passing reductions in milk cost on to consumers as lower retail prices? From the first quarter of 1990 to the first quarter of 1991, farm prices of milk eligible for fluid purposes declined 21.3% while retail prices dropped only 3.8% during that same period (Economic Reporting Service). The lack of responsiveness of retail prices to changes in price at the farm level has raised many questions.

I. Problem Statement

The issue of whether this retail price stability is a result of adjustment lags or an effort to exploit consumers has become a concern in the industry. A recent Wall Street Journal article mentioned the possibility of collusion. A Cable News Network "Dollars & Sense" segment on May 13th, reported that the Department of Agriculture in the State of New York increased the minimum price for fluid milk approximately $0.07 per gallon. A hearing by the Livestock, Dairy, and Poultry Committee on Agriculture, U.S. House of Representatives was held on April 10, 1991 to investigate reasons why reductions in milk cost were not being reflected in retail prices.

A statement from Dr. Andrew Novakovic of Cornell University, summarized a method developed by Olan Forker, that concluded that "complete effects of a price change are not transmitted across a market level in the period of one month (Novakovic)." It continues that retailers should be expected to smooth the variability in price changes over time, suggesting that the price stability is a natural result of the market. William Motes, Vice President of Sparks Commodities, Inc., voiced similar conclusions in his report (Motes). He justifies the spread between raw and retail milk prices by including the high cost of introducing new products, and discusses the switch of consumer tastes and preferences for low fat products. Testimony by Dr. Ronald D. Knutson and Mr. Joe L. Outlaw, indicated that the relationship between raw milk prices and retail milk prices is important for reasons other than price gouging (Knutson and Outlaw). "One of the main functions of a market is to send a signal to producers and consumers..." If raw milk price falls dramatically, as it has over the past year, and the retail price remains constant, the market would be unable to clear due to excesses in supply, causing further reductions in the farm price. This would lead to further farm-level price instability.

Acknowledgements

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Consumers and industry experts alike notice that similar cost changes in raw milk result in different retail price changes. This is evident when analyzing transmission of price when raw milk price is increasing versus decreasing, as shown in the analysis of asymmetrical markets by Forker.

Theoretical Model

The primary question in this paper is "How do retail price adjust to changes in raw milk cost among cities and over time?" The response to this question contains many parts, which can be categorized as: raw milk costs, milk processing, regulation, and market structure. The analysis takes the raw milk price as given and assumes that raw milk price is transmitted to the retail level. Federal and state marketing orders establish and control minimum prices for about 95 percent of the milk used for fluid purposes (Dairy Division).

The area of milk processing includes the procession and distribution of raw milk. Costs of distribution and processing that subsequently affect the retail price are influenced by technology, processing and distribution methods, wages, other factor prices and economies of size.

Regulation also plays an important role in the determination of retail milk prices. In a few cases, states regulate retail prices or enforce minimum retail price markups. Regulation also can include sanitary standards, and packaging standards.

Market structure may influence retail milk prices. The retail price may be affected if processor concentration is large, or it can be affected by the concentration of food retailers. The relative market power of these two groups may influence price levels and relationships between farm and retail milk prices.

The objective of this paper is to find the relationship between cities, and to discuss possible sources of variation that should be included in a complete analysis of the raw and retail milk price situation.

II. Data and Procedures

The data for the analysis were obtained from eighteen cities throughout the United States (Figure 1). Monthly averages were recorded for both raw milk price (Agricultural Marketing Service) and the retail milk price (United States Department of Labor, Table I). Farm price (raw milk cost) were computed as the federal order minimum Class I price plus any over order milk payments.

Two situations were examined with linear regression models using ordinary least squares. The first used monthly data for each city from 1967 to 1978 (time-series). This analysis provided estimates of cost-price behavior for each city during 1967-1978. The second used annual data for a cross-section of the 18 cities. The cross-section analysis provided estimates of the cost-price behavior among cities during each year.

Figure 1 - Distribution of Observed Cities

Two models were estimated. The first used prices in the current month and reflected the price levels, represented as

$P_R = f(P_P)$, where:

P_R = Retail price of milk ($/gal.)
P_P = Raw milk (producer) price ($/gal).

The second used price changes from the previous month, represented as $\Delta P_R = f(\Delta P_P)$, where:

ΔP_R = Change in retail price from previous month

ΔP_P = Change in raw milk (producer) price from previous month.

III. Results

Time Series Results

The coefficients from the first model, relating current math raw milk price to current month retail milk price ranged from 1.15 to 2.07, suggesting the variability of farm retail price relationships among cities (Table I). The magnitude of the coefficient influences the size of the spread between the farm and store level price. For instance, a city with a coefficient of 1.50 shows that the change in price that consumers pay at retail would be 1.5 times the change in the cost of the raw milk. The constant term in the equation acts as a foundation. In this model, the constant acted very significantly to reduce the apparent variability in the relationship among cities shown in Figure 1. Although there is a wide variance in the impact of raw milk price changes on retail price, the constant is significant in reducing the variability of the margin. This is because cities with the lower coefficients had somewhat higher constant terms, and cities with higher coefficients had some what smaller constants. The R^2 coefficient for this model ranged from .88 to .98, showing a high degree of association between the variation in the retail price based on the current month's raw milk price. This is to be expected since prices have shown a long term upward trend and suggest correlation from one month to the next.

The model showing the effect of changes in raw milk price had equally interesting results (Table I). The model used the change in price to remove the trend influence of the raw milk price that made the R^2 value in the first model artificially high. The coefficients ranged from 0,26 to 1.09. This coefficient shows the amount the retail price would change in response to a unit change in raw milk price. Values of under 1.0, found for all but one city, suggest that not all the change in raw milk price is transmitted to the retail price in the current month. This strengthens the case for price "stickiness." The constant values in this model were very small and mostly non significant. The relationships estimated using price changes were not as strong as those estimated for price levels. The R^2

Figure 2

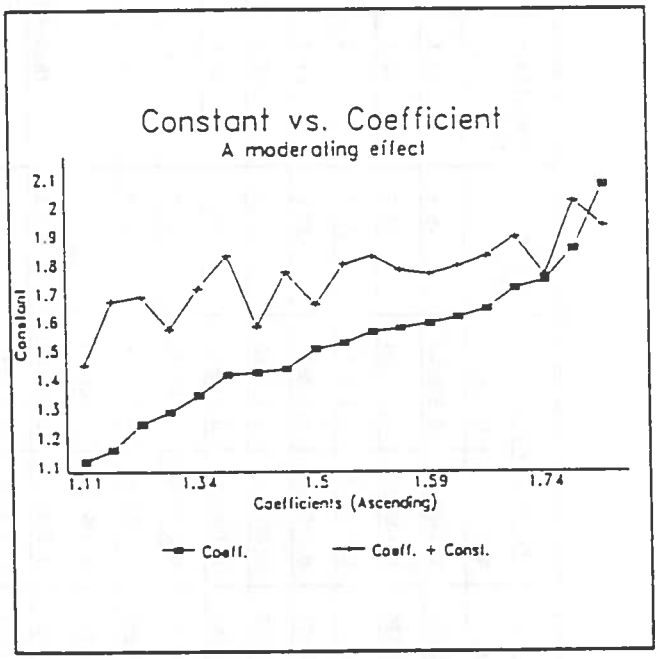


Table 1

City #	Name	Price Levels		Price Changes		Processor Conc. 1>	Food Chain Conc. 2>	Distance 3>	Innovation 4>	Plant Size 5>	Margins 6>
		R^2	Coeff.	R^2	Coeff.						
3	Boston	0.982390	1.282788	0.340508	0.850748	46.9	63.1	51	2.3	1.3169	23.9
10	Philadelphia	0.975451	1.437338	0.400027	0.578868	23.3	64.6	67	-9.5	2.4357	31.6
11	Pittsburgh	0.887499	1.151411	0.175317	0.642416	26.1	49.5	63	21.9	0.9254	29.2
12	Cincinatti	0.985082	1.640693	0.0558530	0.568657	39.6	63.3	64	21.9	1.4861	24.4
13	Cleveland	0.936337	1.421848	0.082176	0.759148	27.0	65.8	74	27.6	1.7653	22.2
20	Chicago	0.971681	1.418285	0.158300	0.824643	39.7	66.4	47	31.9	2.6163	29.6
22	Detroit	0.954033	1.509034	0.205865	0.844938	37.9	n/a	46	6.4	2.4625	23.2
24	Milwaukee	0.963530	1.591686	0.439338	0.975156	36.8	66.9	81	39.0	2.7377	24.5
26	Minneapolis	0.983695	1.749386	0.089920	0.984088	40.6	55.4	27	30.3	3.1111	19.4
29	Kansas City	0.910777	1.711409	0.341336	0.891202	55.8	78.5	35	30.2	1.9231	23.4
30	St Louis	0.975059	1.564203	0.311762	0.879316	64.7	53.1	22	38.5	2.2286	26.0
35	Baltimore	0.978997	1.346006	0.211510	0.629519	25.8	67.6	75	-12.1	1.6283	30.4
36	Washington	0.962021	1.244976	0.174483	0.718905	32.6	86.2	55	6.6	1.7470	28.3
42	Atlanta	0.965286	1.853790	0.465190	1.094311	61.6	68.4	42	-14.5	2.2500	28.3
57	Dallas	0.966937	1.613650	0.131148	0.584432	64.8	n/a	28	24.5	3.5500	24.7
58	Houston	0.972292	2.070403	0.188103	0.613047	91.9	44.3	16	7.8	3.5385	25.9
64	Phoenix	0.893853	1.114519	0.023226	0.266846	79.2	72.2	18	28.8	3.7778	23.8
68	Seattle	0.965977	1.520973	0.202620	0.453944	69.1	62.2	43	22.3	3.3750	26.1
	Average	0.957272	1.513467	0.222038	0.731125	47.96	64.21	47.44	16.88	2.3820	25.82

1> Percentage of milk sales by the largest four processors, 1969-70. (Manchester)
2> Percentage of milk sales by the largest eight food chains, 1972. (Marion et al.)
3> Weighted average of distance in miles from plants to center of serviced market, 1969-70. (Manchester)
4> An index of relative innovation implementation by processors, 1969-70. (Manchester)
5> Average size of processing plant (million lbs. per year), 1969-70. (Manchester)
6> Average standardized margins 1967-69. (Manchester)

coefficients ranged from 0.05 go 0.47, suggesting that the changes in price of the raw milk are not the overwhelming factor associated with changes in the retail prices.

Cross-Section Results

The coefficients for the cross-section of cities were very consistent with the time series results(Table II). The range of

Table II

Results of Cross-Section Analysis of Raw Milk - Retail Price Relationships.

Year	Coeff	R_2
1968	1.2333809	0.352902
1969	1.4537565	0.466539
1970	1.4517434	0.482499
1971	1.4867566	0.268356
1972	1.4708753	0.260246
1973	1.2551700	0.159081
1974	1.1562865	0.172521
1975	1.1007679	0.085718
1976	1.4365071	0.150731
1977	1.6469921	0.217700

coefficients was 1.10 to 1.64, which compares to the average of 1.51 for the time series estimates. Yet, the lower explanation of variation (R_2 values from 0.08 to 0.48) suggests that there are other significant forces modifying the relationships among cities. Possible influences include the level of competition or the relative efficiency of distribution channels between individual markets. Other factors, such as marketing margins and labor costs also would affect the variability of margins between cities The lowest cost-price relationships, shown by the smaller coefficients, coincide with the highly inflationary periods during the early 1970's(Table II). This may show that the processors absorbed some cost increases in raw milk prices and retained higher margins as the price of raw milk declined.

The cross-sectional trial showed a somewhat stable relationship between the farm and retail levels, but the importance of unidentified factors are evident by the inability of the model to explain more of the variation in the model.

IV. Discussion

Farm-retail prices were determined to be asymmetric in the dairy subsector (Kinnucan and Forker). Some explanations for asymmetry in the fluid milk sector include: the cost of changing prices at retail, the recovery of lost profit margins from periods of increasing raw milk prices, or other changes in input costs relevant to the distribution of retail milk.

These results suggest that there is a tendency for the price to rise and fall more slowly at the retail level than at the farm level. The question arises whether this practice is within the normal variance in a market economy or processors, distributors, and retailers are unfairly collaborating to maintain larger price margins and profit margins as farm prices decline.

A basic estimate of the results published by Kinnucan and Forker, can be determined by comparing the coefficients of individual cities when the months are separated into periods when the raw milk price has increased, when it has stayed the same, and when it has decreased. The results for Boston (City 3), roughly parallels the results reported by Kinnucan and Forker, in their more sophisticated analysis. The coefficient when prices were increasing wa 0.69, suggesting that only $0.69 out of my $1.00 increase in raw milk price would be transmitted to the retail price in that month. Conversely, when raw milk

prices were on the decline, the coefficient was 1.07 showing that retail prices declined by $1.07 for each $1.00 decrease in the raw milk price.

The cost-price relationship estimates for the price level model were consistent and the explanatory power was high. The price change model had lower explanatory power. This identified a need to find other sources of variation in the farm to retail price spread. Several potential influences besides the raw milk price was investigated.

Differences in milk processing cost may explain some variation in milk cost-price relationships. Economies of size, distance of plants from consumers, and innovation influence processing and distribution costs. Higher processing and distribution costs have the effect of making the spread between farm and retail prices wider. Market structure variables include processor concentration and food chain concentration. Processor concentration and food chain concentration are expected to result in wider farm-retail price spreads.

There is too much variation in the relationship between farm nd retail prices, shown in the differences in the coefficients among cities, to suggest that there is a constant spread between raw and retail milk prices for all cities. The explanation for these differences comes from other factors that can significantly affect the local price spread. These include the local processor concentration, food chain concentration, distance of processor from center of market, innovation, plant size, impact of state regulation, and processing cost. The two graphs (Figure 3 and 4) show positive and negative influences of these factors on farm retail price spreads. State regulation is excluded because there is no objective way to quantify its effect. The graphs show that if all the variables are weighted equally, there is no discernable trend in which the cities with higher overall margins have greater positive influences and lesser negative influences. To make these influences effective, a weight must be given to each to account for its relative effect on the market. A case can be made for individual cities, such as Houston. Houston has a high coefficient of 2.07, also a very high processor concentration, which is accepted as a positive influence on the margin. Finding a standard weight for these variables is beyond the scope of this paper, but is must be recognized as necessary for a comprehensive evaluation of the fluid milk price. A model was generated combining the cross-sectional data for 1970 to statistically check the predictions made from the graphs. The variables mentioned in Table I was were used as independent variables in the model. These parameters were not significant, in agreement with hypothesis made from the graph. This contradicts the acceptance of these variables as significant which allows for considerable discussion on what factors do significantly enhance the explanatory power of relationships of cost-price spreads between cities. Some contradictory results may be explained by the small number of observations, and the resulting smaller number of degrees of freedom. If the influence of these other parameters was significant, it would be suspected that there would be some indication of that significance, even in this simple model with many limitations. A model to further investigate the effects of these parameters on the raw-retail price spread, should have data for those parameters in a sufficient number of consecutive years to investigate the trends of those variables over time.

Are consumers paying too much for milk? Are processors or retailers securing excessive profits by not passing reductions in milk cost on to consumers as lower retail prices? These models suggest the difficulty in making broad-based assertions when there is so much variability in price spreads between regions and individual cities. A comprehensive investigation of individual markets may determine whether collusion exists on a local level but the variability

Figure 3

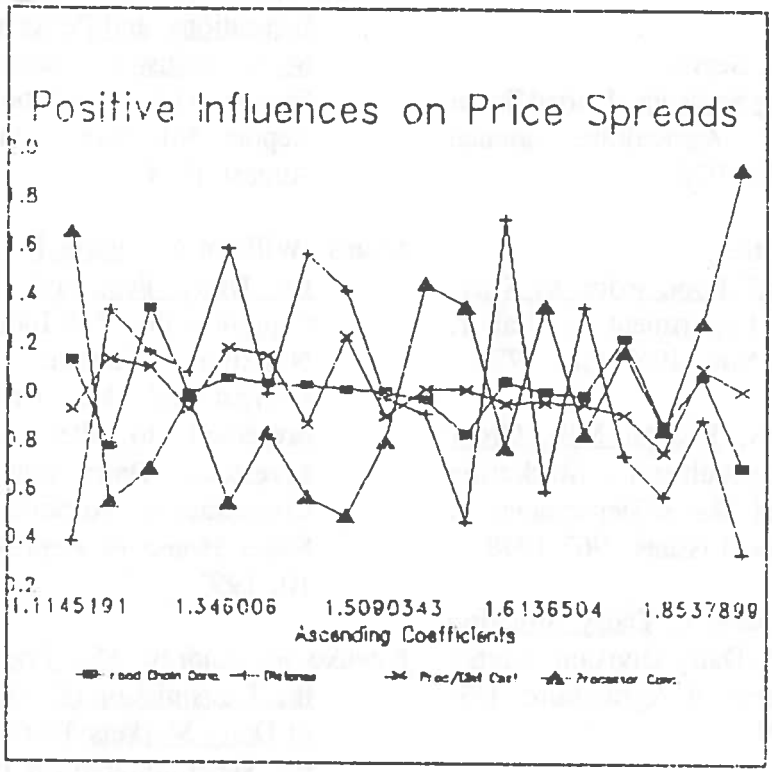
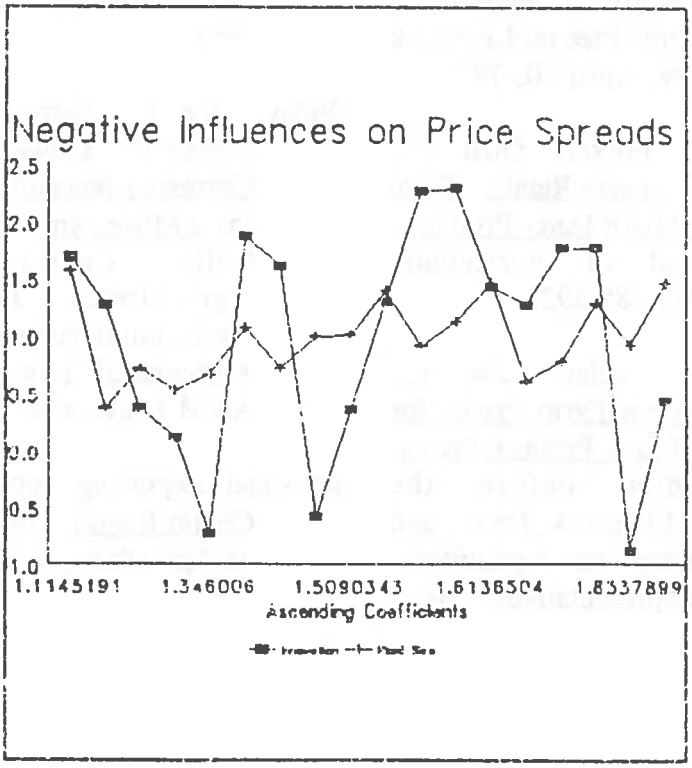


Figure 4



in price spreads between cities makes a judgement on a nationwide basis imprecise.

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