Retailer Concentration and Farm-Retail Price Asymmetry in the Marketing of Fluid Milk in the U.S.

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Price Transmission in Agricultural Markets Workshop
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Overview

- Introduction
  - US Fluid Milk Prices: Farm and Retail
    - ✓ Milk pricing 101
  - Overview of Food Retailer Concentration
  - Previous Evidence of Milk Price Asymmetry
- Review our Modeling Asymmetric Price Transmission
  - Use of Non-Reversible Functions
  - Panel Data with AR errors
- Data and Estimation Procedures
- Preliminary Results
- Conclusions/Next Steps

Increased Concern with Milk Price Volatility

- Recent trends have stimulated major concerns for dairy farm organizations, policy analysts and politicians
  - Evidenced by GAO milk pricing investigation in '04
    - ***Information on Milk Prices, Factors Affecting Prices and Dairy Policy Options***, December 2004
  - Fluid milk price volatility has dramatically increased in recent years
    - Change in Federal dairy policy to more market oriented
    - Increasing importance of world dairy markets
    - Increased perception by some that retailers are adjusting prices asymmetrically

Overview of the Pricing of Milk

- Since 1995, major changes in the way milk is priced under Federal Orders (FO's)
- Currently under the FO system there are 4 classes of milk
  - Minimum prices determined via formulas
    - Class I: beverage milk
    - Class II: fluid cream, cottage cheese, ice cream and mixes, yogurt, infant formula, sour cream
    - Class III: hard cheese, cream cheese
    - Class IV: butter, dried milk products (NFDM, SMP), evaporated/condensed milk

Overview of the Pricing of Milk

- Formulas use monthly average commodity prices to value milk component values where values are unique to class of use (Class I usually the most valuable/Class IV the least)
- NASS surveys butter, cheese, dry whey and NFDM plants *each Friday* for sales data
  - Prices and weekly sales are reported the *next Friday*

Overview of the Pricing of Milk

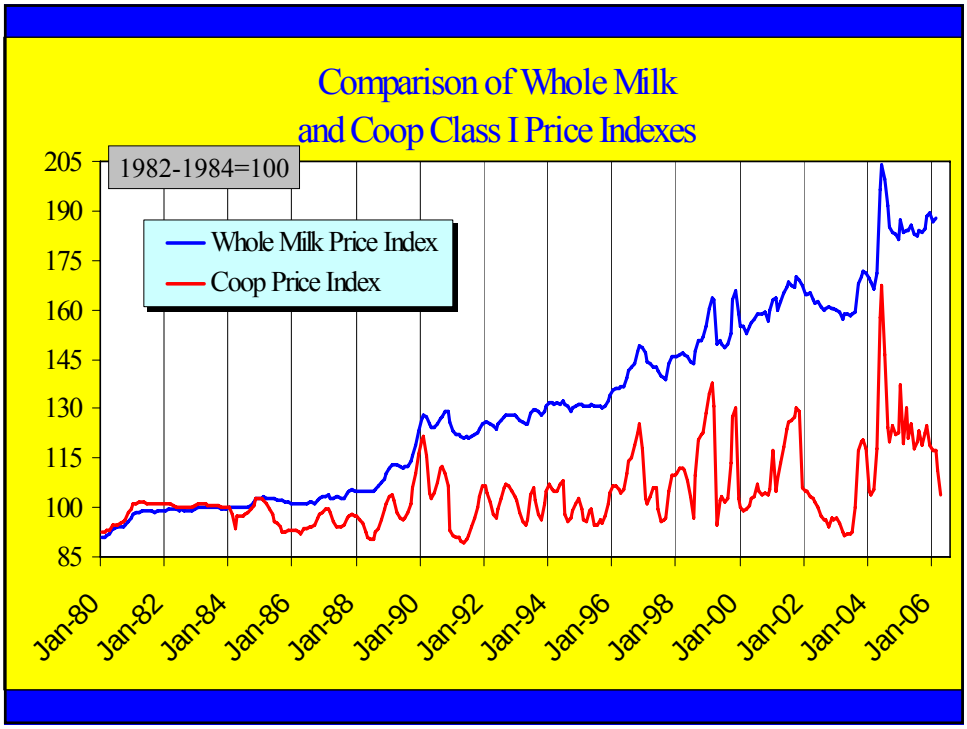
- Class I skim milk and Class I butterfat are **advanced prices**
  - Minimum Class I milk price = 0.965* *advanced* skim milk value + 3.5* *advanced* butterfat value (e.g. farm milk assumed to be 3.5% fat → 3.5 lbs of fat/cwt of milk)
- **Advanced Price** reported on a Friday on or before the 23rd of month *prior* to production
  - For example, April 2006 Class I price:
    - ✓ Announced on Friday March 17th
    - ✓ Based on NASS survey prices for weeks ending March 4th and 10th

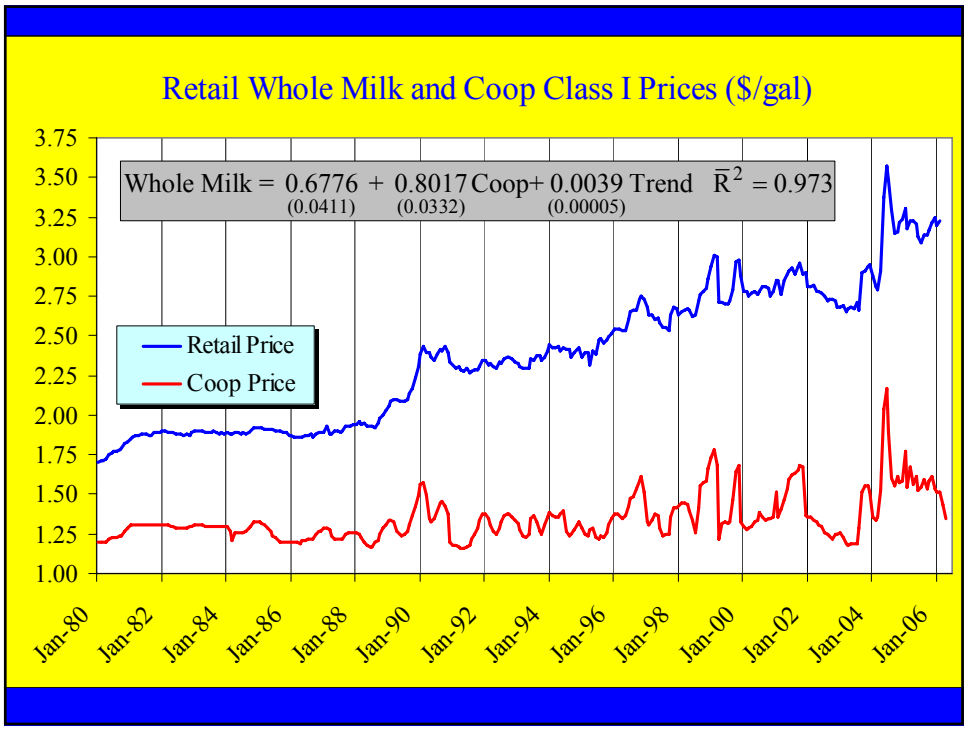
Overview of the Pricing of Milk

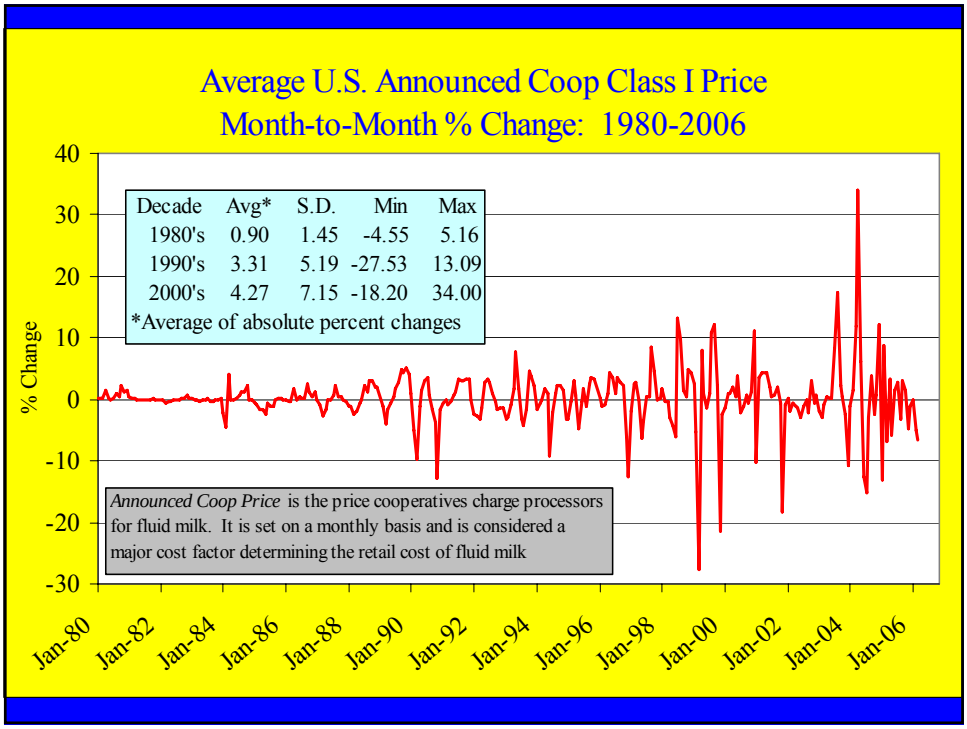
- California has a similar system as the Federal Order (2005: 21% of U.S. milk production)
  - Formulas differ but still based on milk classes
  - Use different source of commodity cash prices
- For more detail refer to the UW Dairy Marketing website: www.aae.wisc.edu/future
- Formula prices are minimum prices
  - Actual prices will differ due to over-order premiums, hauling subsidies (charges) etc.

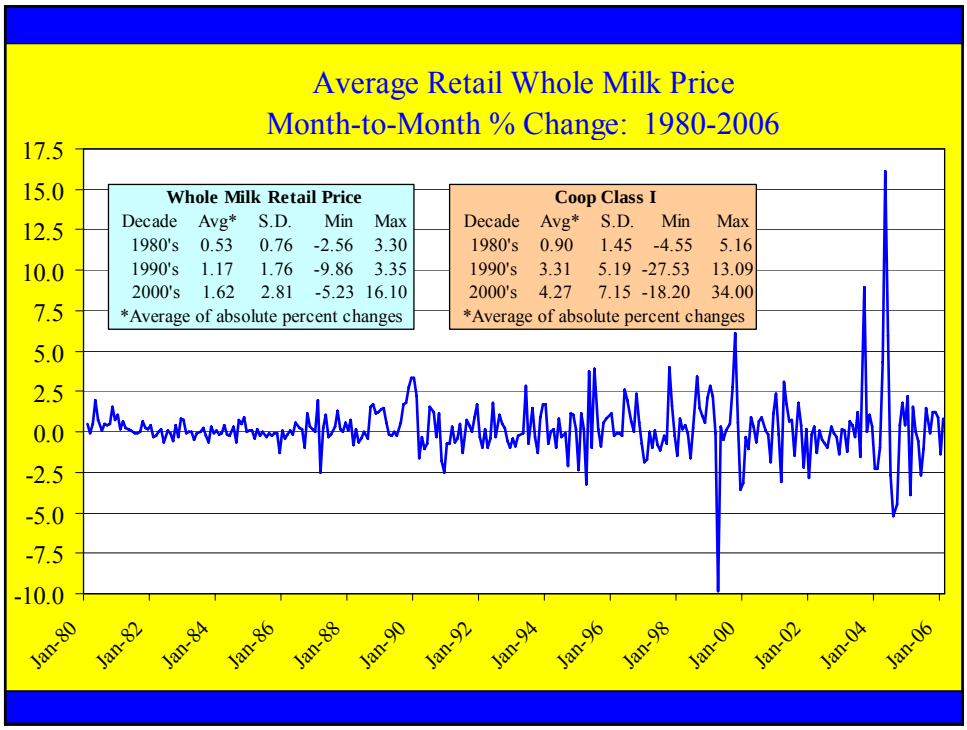
Overview of the Pricing of Milk

- We use monthly Announced Cooperative Class I price to represent prices paid by bottlers to farmers
  - Available for major markets across the U.S.
  - One estimate is that approximately 2/3 of the delivered cost of bottled milk is milk cost
- We have no information as to the markup of bottlers to retailers
  - One trend is the reduction in the number of bottling plants owned by retailers
  - Implicit assumption is that markup does not change


Comparison of Whole Milk
and Coop Class I Price Indexes
1982-1984=100
Whole Milk Price Index
Coop Price Index
205
190
175
160
145
130
115
100
85
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06

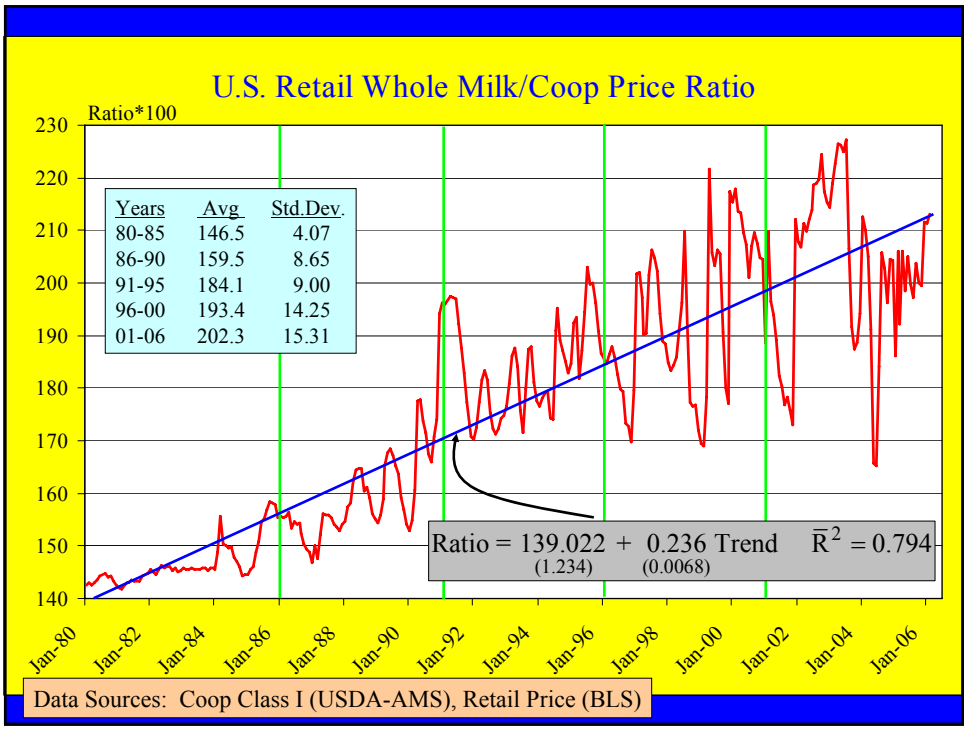

Retail Whole Milk and Coop Class I Prices ($/gal)
Whole Milk = 0.6776 + 0.8017 Coop + 0.0039 Trend $\bar{R}^2$ = 0.973
(0.0411) (0.0332) (0.00005)
Retail Price
Coop Price
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06

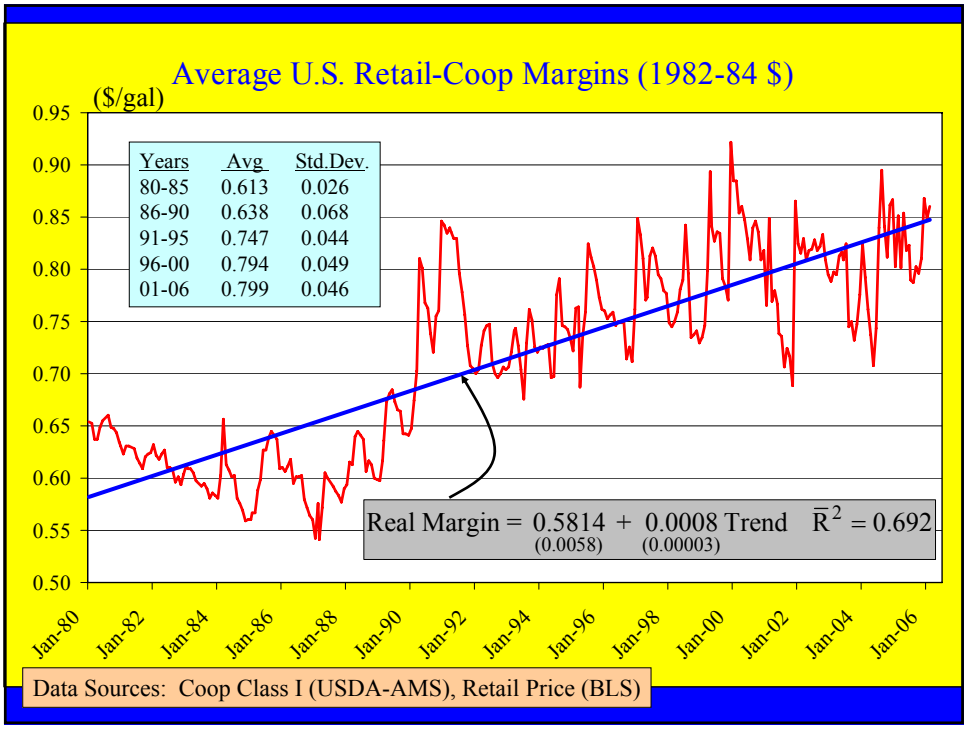

Average U.S. Announced Coop Class I Price
Month-to-Month % Change: 1980-2006
% Change
40
30
20
10
0
-10
-20
-30
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Decade Avg* S.D. Min Max
1980's 0.90 1.45 -4.55 5.16
1990's 3.31 5.19 -27.53 13.09
2000's 4.27 7.15 -18.20 34.00
*Average of absolute percent changes
Announced Coop Price is the price cooperatives charge processors for fluid milk. It is set on a monthly basis and is considered a major cost factor determining the retail cost of fluid milk


Average Retail Whole Milk Price
Month-to-Month % Change: 1980-2006
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Whole Milk Retail Price
Decade Avg* S.D. Min Max
1980's 0.53 0.76 -2.56 3.30
1990's 1.17 1.76 -9.86 3.35
2000's 1.62 2.81 -5.23 16.10
*Average of absolute percent changes
Coop Class I
Decade Avg* S.D. Min Max
1980's 0.90 1.45 -4.55 5.16
1990's 3.31 5.19 -27.53 13.09
2000's 4.27 7.15 -18.20 34.00
*Average of absolute percent changes

Increased Concern with Milk Price Volatility

- Recent trends have stimulated major concerns for dairy farm organizations, policy analysts and politicians
  - Fluid milk price volatility has dramatically increased in recent history
  - Retail-farm price spread continues its upward trend





Increased Concern with Milk Price Volatility

- Recent trends have stimulated major concerns for dairy farm organizations, policy analysts and politicians (may be interrelated
  - Fluid milk price volatility has dramatically increased in recent history
  - Retail-farm price spread continues its upward trend
  - Increased food retailing concentration over the last 3 decades

Increased Concern with Milk Price Volatility

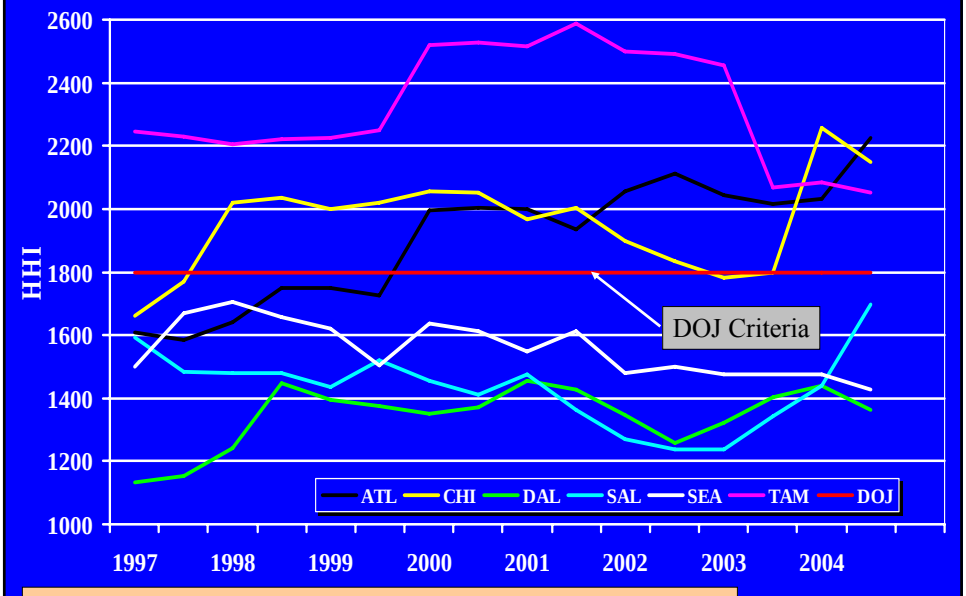
- A measure of concentration: Herfindahl-Hirschman Index (HHI)

$$HHI = \sum_{i=1}^{N} \left(100 \frac{s_i}{S} \right)^2$$

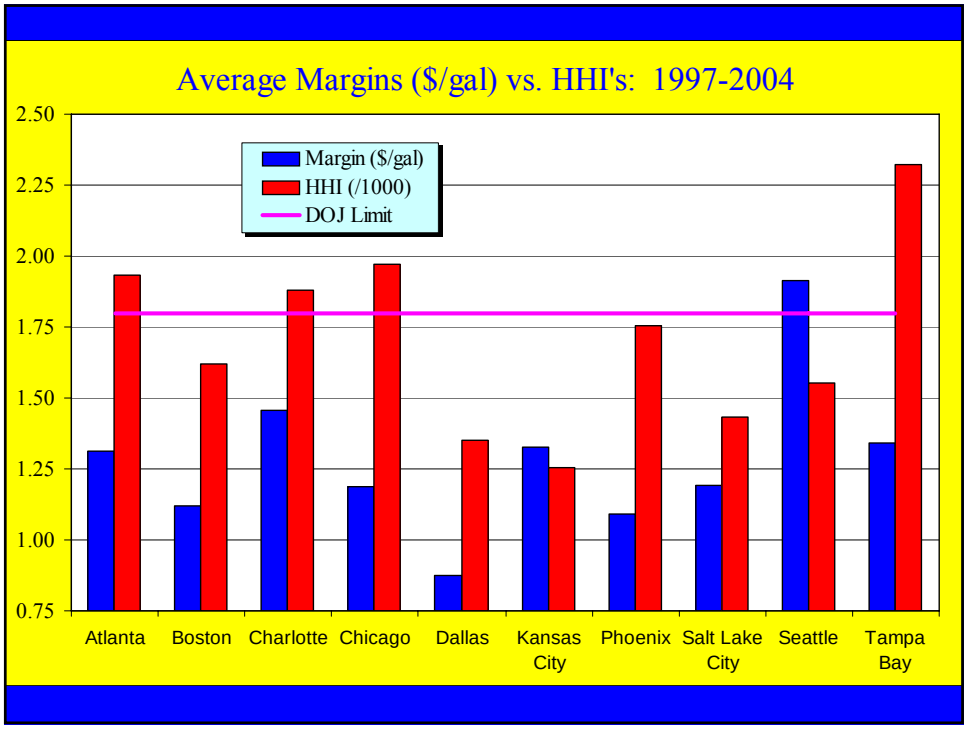
where s_i is the value of sales by the i^{th} firm and S is the total value of market sales in a particular market

- U.S. Dept. of Justice Guidelines wrt HHI:
  - 1000-1800: Moderately Concentrated
  - >1800: Concentrated
  - Mergers adding $\geq$ 100 to HHI in concentrated markets raise antitrust concerns

Retail Grocery Sector HHI Values



Data Sources: HHI (Total Value of Supermarket Sales, Market Scope)



Increased Concern with Milk Price Volatility

- Recent trends have stimulated major concerns for dairy farm organizations, policy analysts and politicians
  - Fluid milk price volatility has dramatically increased in recent history
  - Retail-farm price spread continues its upward trend
  - Increased food retailing concentration over the last 3 decades
  - Evidence of asymmetric cost pass-through for fluid milk retailers

Asymmetric Price Transmission

- Evidence of Asymmetry in US Milk Markets
  - Kinnucan and Forker (1987): Annual U.S. Aggregate Data for Major Dairy Products
  - Hansen et. al. (1994): Annual U.S. Aggregate Fluid Milk Data
  - Romain et. al. (2002): Aggregate New York State Fluid Milk Data
  - Capps and Sherwell (2005): Monthly Sales Data for 2% and Whole Milk, 7 US Cities similar to that used here
  - GAO(2004) meta-analysis of previous price asymmetry analyzes of the U.S. milk market

Asymmetric Price Transmission

- Why should we be concerned with the price transmission process for fluid milk?
  - Relationship between farm and retail prices provide insights into marketing efficiency
  - Implications as to consumer and producer welfare
  - Presence of asymmetric price transmission is considered to be evidence of market failure or abuse of market power
  - Continuation of trend of farm milk price variability
  - Continuation of food retailing concentration

Research Questions

- Is there evidence of asymmetric farm-retail price transmission in the US fluid milk sector?
- Does magnitude of asymmetry vary with market and spatial concentration *across* cities?
- Do changes in market and spatial concentration over time affect the magnitude of asymmetry *within* cities?

Econometric Model

- Based on the model originally developed by Wolframm(1971) and extended by Houck(1977)
  - Approach has been used extensively in the analyses of price transmission of agricultural commodities
    - ✓ Pork: Boyd and Brorsen (1988)
    - ✓ Fed Cattle: Bailey and Brorsen (1989)
    - ✓ Peanuts: Zhang, Fletcher and Carley (1995)
    - ✓ Wheat: Mohanty, Peterson and Kruse (1995)
    - ✓ Apples: Willett, Hansmire and Bernard (1997)
    - ✓ Rice, Beans, Tomatoes: Aguiar and Santana (2002)

Econometric Model

- Houck (1977) approach used extensively in the analysis of fluid milk price asymmetry
  - Kinucan and Forker (1987)
  - Romain, Doyon and Frigon (2002)
  - Capps and Sherwell (2005)
  - Carman and Sexton (2005)

Econometric Model

- We improve upon previous research
  - More current data encompassing periods of dramatic farm (Coop Class I) price increases and decreases
    - ✓ April 2003: $13.74
    - ✓ June 2004: $25.16

    } 83.1% ↑
  - Incorporate explicit measures of concentration as explanatory variables
    - ✓ CR2, CR4 (% of total retail grocery store sales by the 2 and 4 largest firms, respectively)
    - ✓ Herfindahl-Hirschman Index (HHI)
    - ✓ Spatial Concentration (Supermarkets/1,000 pop)

Econometric Model

- We improve upon previous research
  - Incorporate a variety of definitions of our dependent variable to examine asymmetry to examine robustness of our conclusions
    - ✓ Change in retail price (reported here)
    - ✓ Change in farm-retail margin
    - ✓ Percent change in farm-retail margin
  - Given our use of city/retail firm data we can examine differences across city and/or firms
  - Incorporate alternative methods for accounting for panel nature of our dataset (Fixed Effects used here)

Econometric Model

- General markup model used by Kinnucan and Forker (1987) and Romain et al (2002)
  - $P_R=f(P_F, MC, Q) \rightarrow P_R-P_F=g(P_F, MC, Q)$
    - ✓ $P_R \equiv$ retail price
    - ✓ $P_F \equiv$ "farm" price
    - ✓ MC ≡ marketing cost
    - ✓ Q ≡ quantity marketed
  - Unlike previous analyses we focus on changes in retail prices instead of margins

Econometric Model

- Basic Houck model
  - $RP_t \equiv$ retail price in the t^{th} period
  - $\Delta RP_t \equiv RP_t - RP_0$
  - $WP_t \equiv$ wholesale (farm) price in the t^{th} period
  - $\Delta WP_{It} \equiv$ change in wholesale price if there is an *increase* from t-1 to t
  - $\Delta WP_{Dt} \equiv$ change in wholesale price if there is a *decrease* from t-1 to t
  - $WP_{It} \equiv$ cumulative sum of period to period *increases* in wholesale price
  - $WP_{Dt} \equiv$ cumulative sum of period to period *decreases* in wholesale price
  - Trend ≡ trend variable

Econometric Model

- Basic Houck model

$$\Delta RP_{t0} = \beta_0 Trend_t + \beta_1 \sum_{j=1}^{t} \Delta WP_{Ij} + \beta_2 \sum_{j=1}^{t} \Delta WP_{Dj} + \varepsilon_t$$

$$= \beta_0 Trend_t + \beta_1 WP_{It} + \beta_2 WP_{Dt} + \varepsilon_t$$

$$\Delta RP_{t0} \equiv RP_t - RP_0 = \sum_{i=1}^{t} \left(RP_i - RP_{i-1} \right)$$

$$\Delta WP_{Ii} \equiv WP_i - WP_{i-1} \text{ if } WP_i > WP_{i-1} \rightarrow WP_{It} \equiv \sum_{j=1}^{t} \Delta WP_{Ij}$$

$$\Delta WP_{Di} \equiv WP_i - WP_{i-1} \text{ if } WP_i < WP_{i-1} \rightarrow WP_{Dt} \equiv \sum_{j=1}^{t} \Delta WP_{Dj}$$

Example of the Creation of Cumulative Price Variables

Time	WP	ΔWP_I	ΔWP_D	WP_I	WP_D	RP	ΔRP_0
0	2	---	---	---	---	5	----
1	6	4	0	4	0	7	2
2	9	3	0	7	0	11	6
3	5	0	-4	7	-4	9	4
4	7	2	0	9	-4	9	4
5	6	0	-1	9	-5	10	5
6	3	0	-3	9	-8	8	3
7	5	2	0	11	-8	8	3
8	9	4	0	15	-8	12	7
9	14	5	0	20	-8	16	11

Econometric Model

- Our empirical model
  - Analysis of **Private Label Whole Milk** eliminates
    - ✓ Brand effect differences across firm/city
    - ✓ Milk quality effects (fat content) across firm/city
  - Test for asymmetry for both farm price and marketing cost changes
  - Incorporate Almon lag structures
  - Incorporate AR(1) error structure (city-specific ρ's)
  - Test for long-run and short-run asymmetry

Econometric Model

Number of Lags

- Our empirical model

$$\Delta RP_{t0j} = \beta_1 Trend_t + \sum_{i=0}^{m_1} \beta_{2i} MC^{P}_{t-i,j} + \sum_{i=0}^{m_2} \beta_{3i} MC^{N}_{t-i,j} + \sum_{i=0}^{n_1} \beta_{4i} COOP^{P}_{t-i,j}$$

$$+ \sum_{i=0}^{n_2} \beta_{5i} COOP^{N}_{t-i,j} + \beta_6 Q_{tj} + \beta_7 HHI_{tj} + \beta_8 NE\_COMP_{tj}$$

$$+ \sum_{i=1}^{12} \psi_i MONTH_{it} + \sum_{i=1}^{J} \tau_i CITY\_FIRM_{itj} + \varepsilon_{tj} \quad (t = 1.....T,\ j = 1.....J)$$

Trend≡trend variable, t ≡ time period, j ≡ city/firm, T ≡ total no. of months, J ≡ total no. city/firms, N & P superscripts refer to pos/neg changes, MC ≡ marketing costs, COOP ≡ cooperative Class I price, MONTH ≡ monthly dummy variable, CITY_FIRM ≡ city/firm dummy variable, NE_COMP ≡ Northeast Compact dummy variable, Q ≡ total value of milk sales

Various Hypothesis Tests

- Long-run price transmission symmetry (H.1)

$$H_0 : \sum_{i=0}^{n_1} \beta_{4i} + \sum_{i=0}^{n_2} \beta_{5i} = 0$$

Cumulative value of farm price increase effects= value of price decrease effects?

- Short-run price transmission asymmetry requires at least one of the following to occur (H.2)

$$H_0 : \sum_{i=0}^{z} \beta_{4i} + \sum_{i=0}^{z} \beta_{5i} \neq 0 \text{ for } z = \left[1,...,\max\left(n_1,n_2\right)-1\right]$$

To fully assess asymmetry characteristics we need to examine short run asymmetry as noted by Hansen et al, (1994) as short run asymmetry can occur without long-run asymmetry and vice versa

Various Hypothesis Tests

- Complete transmission of farm price changes (H.3)

$$H_0: \sum_{i=0}^{n1} \beta_{4i} = 1 \text{ (increase)}; \sum_{i=0}^{n2} \beta_{5i} = -1 \text{ (decrease)}$$

In fluid milk sector it seems reasonable to assume a fixed proportion production technology where 1 gallon of farm milk will result in 1 gallon of milk sold to the consumer

- Speed of adjustment the same for positive and negative changes for each period (H.4)
  - Joint test: $\beta_{4i} + \beta_{5i} = 0$ for i = (1,…,min[n1,n2])

Description of Our Data

- Retail Price Information
  - Information Resources Incorporated (IRI)
  - UPC Level
  - For this analysis: **private label, whole milk**
  - Sales values and gallons sold by firm (not outlet)
  - 10 cities included in this analysis
    - ✓ Atlanta, Boston, Charlotte, Chicago, Cleveland, Dallas, Kansas City, Phoenix, Salt Lake City, Seattle, Tampa
  - Monthly (derived from weekly): March 1997-Dec. 2004 (94 months)
  - Key players (firms) in each city (2-5 firms and total)

Description of Our Data

	1 week ending 7/4/2004	1 week ending 7/11/2004
City A/Firm A		
Dollar Sales		
CATEGORY - MILK	928,193	937,767
RFG SKIM/LOWFAT MILK	630,054	634,081
AHAVA FOOD	63	50
NEW SQUARE	63	50
HORIZON ORGANIC	18,599	17,421
MCNEIL CONSUMER PRODUCTS	10,056	10,244
LACTAID	-	-
LACTAID 100	10,056	10,244
DARIGOLD	20,208	17,644
PRIVATE LABEL	581,128	588,722
RFG WHOLE MILK	211,368	217,750
AHAVA FOOD	42	59
HORIZON ORGANIC	11,230	10,859
MCNEIL CONSUMER PRODUCTS	2,743	3,169
LACTAID 100	2,743	3,169
WEST FARM FOODS	7,876	7,102

Description of Our Data

- *Farm level* milk price
  - Monthly Cooperative Class I price
    - ✓ Prices charged to fluid milk distributors by dairy cooperatives/bargaining federations
    - ✓ Reasonable proxy for the cost of raw product to fluid milk bottlers
  - Prices specific to each city in this study
  - Can be downloaded from a spreadsheet on the *UW Dairy Marketing Website*: www.aae.wisc.edu/future/cash_prices_class1.htm
- All monetary data deflated by city-specific CPI's

Description of Our Data

- Marketing Cost Index
  - Based on Romain, Doyon and Frigon (2002)
  - 54% Processing
    - ✓ 26% processing labor
    - ✓ 24% packaging costs
    - ✓ 4% energy
  - 36% Retail
    - ✓ 31% retail labor
    - ✓ 5% energy
  - 10% Transportation
- BLS data used for all components
- Aggregated using Tornquist-Theil Index using the above budget shares

Description of Our Data

- Market Concentration Measures
  - Obtained from bi-annual *Market Scope* publication of supermarket sales
  - Complete census of supermarket sales in major markets across the U.S.
  - Defines markets to match IRI market definitions
  - Values interpolated between publication periods (e.g. every 6 months) given our use of monthly milk sales data

Preliminary Econometric Model Results

- Above model structure assumed a one-way fixed effects model
  - Tested using F-test proposed by Baltiga (1995)
    - ✓ H_0: Pooled Data
    - ✓ $F(J-1,JT-J-K)=\frac{(R^2_{FE}-R^2_{pooled})/(J-1)}{(1-R^2_{FE})/(JT-J-K)}$ (No. of city-firms)
    - ✓ F-Stat of 71.8 → reject H_0 → Fixed Effects
- Total Number of Observations: 2,852
  - 31 City/Firm Combinations

Preliminary Econometric Model Results

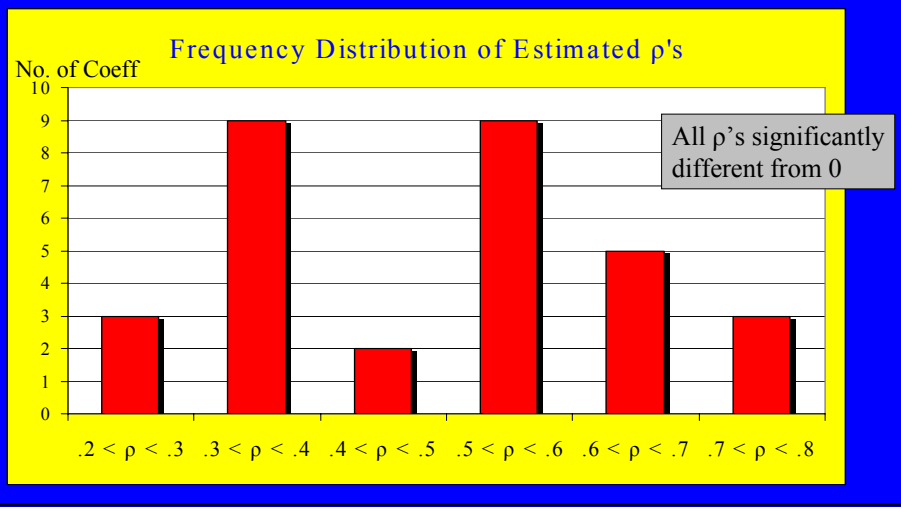
- Lag length for MC and COOP determined using AIC criterion (Almon lag structure of degree 3)

$$AIC = \ln\left(\frac{SSE}{T}\right)+\frac{2K}{T}$$ (Judge, et al., 1988, p.728)

  - Initially assumed 6 months for all lagged variables
  - If a lag variable removed and AIC decreases, lag variable should be left out
    - ✓ →All lags removed for MC
    - ✓ →Two lag periods for COOP price change
- $\bar{R}^2 = 0.293$ $r_{y,y^*} = 0.746$
  - ✓ Remember no intercept

Preliminary Econometric Model Results

- Summary of AR(1) Results: 31 ρ values
  - Estimated via Cochrane-Orcutt



Preliminary Econometric Model Results

- Summary of Results: Fixed Effect Coefficients (City/Firms)

City	Retailer #				
Atlanta	11	13	22		
Boston	3	16	18	19	
Charlotte	2	5	7	22	
Chicago	4	9			
Dallas	1	11	12	14	20
Kansas City	8				
Phoenix	1	6	16		
Salt Lake	1	17			
Seattle	1	16			
Tampa Bay	1	10	13	21	22

Indicates stat. sign.

15 out of 31

Preliminary Econometric Model Results

- Summary of Results: Misc. Coefficients

Variable	Coefficient	S.E.
Q	-0.0099*	0.0008
HHI	0.1183*	0.0423
NE_COMP	-0.0153	0.0336

*significant at the 0.05 level

Preliminary Econometric Model Results

- Summary of Results: Cumulative Change Variables, MC and COOP

Variable	Coeff.	S.E.	Variable	Coeff.	S.E.
MC_0^P	-0.0019	0.0022	MC_0^N	-0.0051*	0.0021
$COOP_0^P$	0.7312*	0.0467	$COOP_0^N$	-0.2048*	0.0400
$COOP_1^P$	0.0499	0.0585	$COOP_1^N$	-0.2698*	0.0410
$COOP_2^P$	-0.0291	0.0524	$COOP_2^N$	-0.1719*	0.0359

*significant at least the 0.05 level

Preliminary Econometric Model Results

- Summary of Results: Hypothesis Tests

Null Hypothesis	Value	S.E.
Long-run farm price transmission symmetry (H.1)	0.1057*	0.0317
Short run price trans. symmetry w/0 lag (H.2)	0.5263*	0.0640
Short run price trans. symmetry w/1 lag (H.2)	0.3063*	0.0685
Short run price trans. symmetry [Joint Test] (H.2)	$\chi^2(2)= 71.1$*	
Complete trans. of pos. farm price changes (H.3)	-0.2481*	0.0394
Complete trans. of neg. farm price changes (H.3)	0.3538*	0.0379
Speed of Adjustment [Joint Test] (H.4)	$\chi^2(3)= 73.2$*	

Preliminary Econometric Model Results

- Summary of Results: Other Characteristics

Price Transmission Characteristic	Value	S.E.
% of pos. Δ Coop price passed through $\left(\sum_{i=0}^{2} \beta_{4i}\right)$	0.7519*	0.0394
% of neg. Δ Coop price passed through $\left(\sum_{i=0}^{2} \beta_{5i}\right)$	-0.6462*	0.0379
Price Transmission Elasticity (Positive, ε^P)	0.3820*	0.0200
Price Transmission Elasticity (Negative, ε^N)	0.3283*	0.0192

Note: Transmission Elasticity is defined as the percentage impact on retail prices for a percentage change in COOP price after all lag effects considered: e.g., $\sum_{i=0}^{m_1} \beta_{4i} \left(\overline{COOP}/\overline{RP}\right)$

Next Steps

- Extend method by which market concentration incorporated into the model
  - Allow the HHI to be a slope shifter
    - ✓ Interact with the COOP and MC variables
  - Modify HHI to account
    - ✓ Population differences across cities
    - ✓ Number of retailers across cities
  - Account for branding/milk type
- More fully explore the time series aspects of the data