Retail Dairy Prices Fluctuate With the Farm Value of Milk

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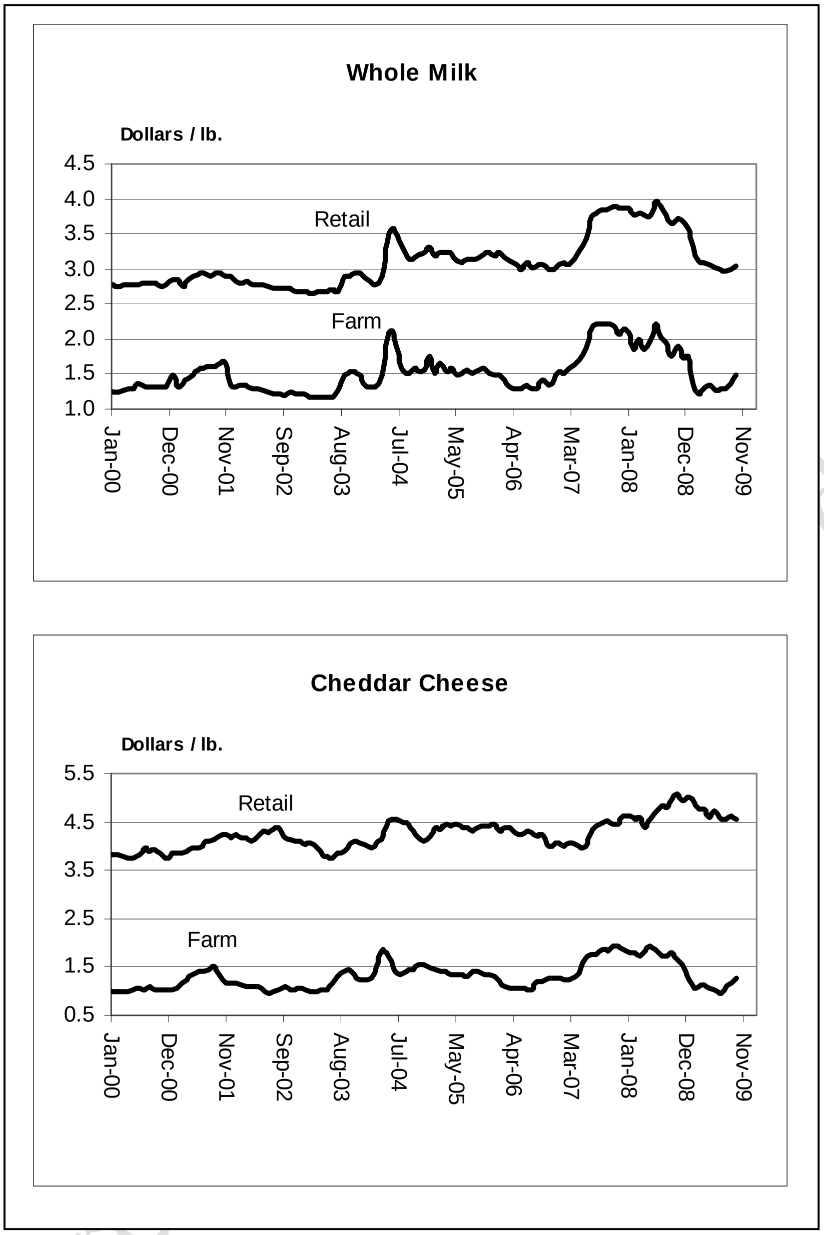
Changes in the price of milk at the farm gate affect retail dairy prices. When the farm price of milk increases, marketers raise retail prices for fluid milk and manufactured dairy products. However, when farm prices fall, do marketers reduce retail prices as quickly and completely?

In 2009, a sharp drop in farm milk prices occurred and retail prices showed little immediate response. Echoing the views of other market observers, *The Cheese Reporter* described retail price trends as “strange” and “frustrating” (Groves, p. 2).

We investigate the relationship among farm and retail prices for whole milk and Cheddar cheese. Retail and farm prices for these two products are found to be cointegrated. That is, retail prices move somewhat independently of farm prices in the short run, but over the long run, tend to fluctuate with them. Moreover, retail price trends between December 2008 and fall 2009 were consistent with cointegration. Finally, we identify key differences in how changes in the farm price of milk are transmitted to retail for the cases of whole milk and Cheddar cheese.

Dairy Price Trends, 2000-09



Error Correction Model

Farm-to-retail price transmission has been researched extensively, as noted in literature reviews by Meyer and von Cramon-Taubadel (2004) and Frey and Manera (2007).

When farm and retail prices are cointegrated, it is common to specify the longrun relationship between them as:

$$(1) \qquad R_t = \beta_0 + \beta_1 F_t + \varepsilon_t$$

where R_t is retail price, F_t is farm receipts, β_0 is the value of marketing services, and ε_t is a stationary error term. Other variables may be included to account for changes over time in the value of marketing services, if needed.

In the short run, farm and retail prices may move with substantial independence. A very general error correction model (ECM) posits that changes in retail price depend on changes in the farm price and an error correction term (ECT):

$$(2) \quad \Delta R_t = \sum_{k=0}^{M}\left(\alpha_{1,k}^{+} D_{t\text{-}k}^{+} \Delta F_{t-k}\right) + \sum_{k=0}^{N}\left(\alpha_{1,k}^{-} D_{t\text{-}k}^{-} \Delta F_{t-k}\right) + \gamma_1 ECT_t + \gamma_2 ECT_t^2 + \gamma_3 ECT_t^3 + u_t$$

where

$ECT_t = \varepsilon_{t-1}$ is the deviation in retail price from the longrun relationship in (1),

γ is a vector of adjustment parameters,

$D_{t\text{-}k}^{+}$ and D_{t-k}^{-} are indicator variables that split $\Delta F_{t\text{-}k}$ into rising and falling regimes:

- $D_{t-k}^{+} = 1 \text{ if } F_{t\text{-}k} \geq F_{t\text{-}k\text{-}1}$ and 0 otherwise.

- $D^{-}_{t-k} = 1$ if $F_{t-k} < F_{t-k-1}$ and 0 otherwise, and

$\alpha^{+}_{1,k}$ and $\alpha^{-}_{1,k}$ are parameters that measure the direct effect of contemporaneous and past changes in the retail price on the farm prices.

The procedure of Wolffram (1971) and Houck (1977) is used to test whether changes in farm price affect retail prices symmetrically. Symmetry requires that retail prices adjust by the same amount in all periods after an increase or decrease in farm price (i.e., $\alpha^{+}_{1,k} = \alpha^{-}_{1,k}$ for all k).

Even if price transmission is asymmetric in the short run, farm price shocks do not permanently alter a cointegrating relationship. For example, if processors do not initially pass down a decrease in farm prices, retailers may look for cheaper sources of milk and cheese. Competition among processors could ultimately eliminate any extra margin of profit that processors had temporarily been collecting.

The ECT measures how far retail prices deviate from their longrun relationship with farm prices and, given the ECT, the speed of adjustment parameters (γ) describe how retail prices adjust back to this relationship. If, for example, R_t exceeds its expected value given F_t, then ε_t in (1) is positive as is the value of ECT in (2) in the next period. The "cubic polynomial" nonlinear ECM allows for a very general adjustment process (see Escribano 2004).

Modeling and Estimation Results

Monthly data from January 2000 to December 2008 are used for estimation. Using Johansen's procedure, we concluded that farm and retail prices shared a cointegrating (longrun) relationship over this period (Johansen, 1991, 1995). We then estimated cubic polynomial ECMs for whole milk and Cheddar cheese. Since farm prices fell sharply after December 2008, we treat observations from 2009 as potential outliers. Indeed, as noted earlier, some observers claim that retail price movements in 2009 were strange.

Asymmetry in Whole Milk Prices

Price transmission is asymmetric for whole milk. For a 20-cent increase in farm price, we expect retail prices to rise by 17 cents (0.833 x 20 cents) in the same month. By contrast, if the farm price were to fall by 20 cents, we would expect retail prices to decrease by only 6 cents that month.

Retail prices revert to their longrun relationship with farm prices according to the speed of adjustment parameters, γ. For example, if R_t exceeds its expected value by 20 cents, we predict that next month's change in the retail price will be 2 cents (-0.09 x 20 cents) less than otherwise.

Cheddar Cheese Retail Prices Adjust More Slowly

The retail price of Cheddar cheese adjusts more slowly to changes in the farm value of milk. According to our estimates of $\alpha_{1,k}^{+}$ and $\alpha_{1,k}^{-}$, an increase (decrease) in the farm price does not directly cause retail prices to increase (decrease). Farm price changes are later transmitted to retail through the ECT and the speed of adjustment parameters. That is, transmission occurs only as retail prices revert back to their longrun relationship with farm prices. Moreover, we find evidence of asymmetry in this adjustment process.

Deviations that temporarily squeeze marketing margins are corrected more quickly than are deviations that temporarily inflate marketing margins. For example, if retail price exceeds its expected value by 20 cents, we predict ΔR_{t+1} will be 7 cents higher than otherwise. By contrast, if R_t is 20 cents too high, we expect ΔR_{t+1} will be just 2 cents lower than otherwise.

Estimation results for error correction models, whole milk and Cheddar cheese

Error correction model		
	Whole milk	Cheddar cheese
ECT	-0.089* (0.03)	-0.193* (0.078)
ECT^2		0.627* (0.283)
ECT^3		-0.854* (0.366)
$\Delta F_t \times D_t^+$	0.843* (0.052)	
$\Delta F_t \times D_t^-$	0.31* (0.062)	
$\Delta F_{t-1} \times D_{t-1}^-$	0.33* (0.06)	
ΔF_t		-0.288* (0.089)
Cointegrating relationship		
Constant	0.819	2.942
F_t	1.467	0.9
Model fit and diagnostics		
Sum of squared errors (SSE)		
AIC**	0.139	0.526
R^2	-390.45	-249.64
F-test for autocorrelation***	0.821	0.433
Sum of squared errors (SSE)	1.463	0.238

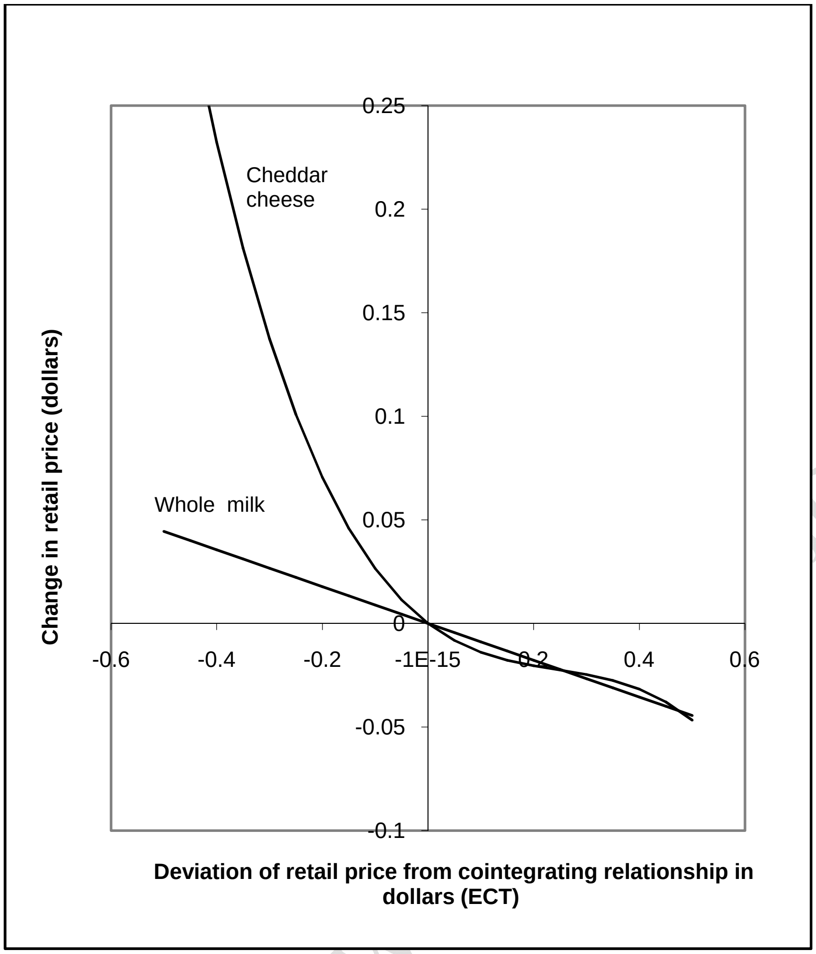
* = .05 level; standard errors are in parentheses.

**Calculated as AIC = 2p + t[ln(2πSSE/t) + 1 where p = number of unknown parameters and t= number of observations used.

***Breusch-Godfrey test with null hypothesis that the first three residual autocorrelations are jointly zero. Critical value of $F_{(0.05,3,90)} = 2.71$ is used.

Note(s): Simultaneous, nonlinear least squares estimation of error correction model in (2) and cointegrating relationship in (1). For whole milk, our estimates of ECT^2 and ECT^3 were statistically insignificant. The model was re-estimated excluding these terms. For Cheddar cheese, our estimates of $\alpha_{1,k}^+$ and $\alpha_{1,k}^-$ were not significantly different statistically. The model was re-estimated without splitting ΔF_t and ΔF_{t-1} into rising and falling regimes. However, ΔF_{t-1} was statistically insignificant.

Error correction for whole milk and Cheddar Cheese



Retail Price Trends Are Consistent With Cointegration in 2009

Retail price trends for whole milk and Cheddar cheese between December 2008 and the Fall of 2009 were consistent with cointegration between retail and farm prices. Retail prices ultimately fell as much as farm prices did.

Nature of Price Transmission Is Different for Cheese and Milk

Price transmission is asymmetric for both whole milk and Cheddar cheese. Differences in the nature of price transmission between the products are also evident. Product characteristics may be responsible for these differences:

Processors may consider farm milk a variable input when making sales arrangements with a retailer. Pasteurizing, homogenizing, and adjusting fat content is a relatively quick process for fluid milk. If farm prices go up (down), processors probably can reduce (expand) production. That reduction (expansion) soon will lead to higher (lower) wholesale and retail prices.

By contrast, cheese manufacturers may deliver barrels or blocks of their products to intermediary firms that age, cut, shred, wrap, or otherwise do some further processing before sending the product in a new form to wholesalers/retailers. It is possible that these intermediaries may negotiate prices with wholesalers and retailers further along the supply chain without regard to either current farm prices or prices paid for the milk now in the cheese.

Farm and retail dairy prices, December 2008 to October 2009

	Milk		Cheese	
Month/year	Farm	Retail	Farm	Retail
		Dollars		
2008				
December	1.74	3.68	1.54	4.95
2009				
January	1.76	3.58	1.23	5.01
February	1.35	3.32	1.04	4.92
March	1.22	3.12	1.10	4.76
April	1.30	3.08	1.13	4.76
May	1.35	3.07	1.07	4.61
June	1.27	3.01	1.03	4.72
July	1.30	2.99	0.97	4.56
August	1.29	2.98	1.08	4.55
September	1.37	2.98	1.16	4.61
October	1.48	3.05	1.28	4.55

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