# The Theory of Price Collars: Linking of Prices in a Market Channel to Redress the Exercise of Market Power

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# Introduction

- Marketing channels for many goods involve the production of a raw commodity that is processed and then distributed to retailers for sale to consumers.
- Either the processing industry or the retailing industry or both may exercise substantial market power ultimately against raw commodity suppliers or consumers, the disorganized (competitive) economic groups at the ends of the market channel.

# Introduction

- This paper develops a theory of price collars to regulate pricing in such a channel.
- Price collars link raw product, wholesale and retail prices but do not explicitly set such prices.
- For example, a wholesale price collar could limit the wholesale price to 140% of the raw commodity price, and a retail price collar could limit retail price to 130% of the wholesale price.

# Introduction

- Following Slade (1995) and others we initially assume that each retail firm has a monopoly based upon geographic location and product differentiation, i.e. the firm's demand curve for the processed product under analysis is downward sloping.
- What is the nature of vertical competition with processors?

# Introduction

- We assume that retailers regard the wholesale milk prices as a parameter when maximizing profits. This may be due to one of two possibilities. Processing may be effectively competitive with a flat supply curve or retailers may play a vertical Nash game, i.e. maintain that their pricing moves have no effect on a processing oligopoly that feed back through changes in wholesale price to alter their pricing strategies.

# Pre-Regulation Retail Pricing with Retailer Price Leadership under Regulation

- Before the regulation is implemented, a monopoly retailer solves the following profit-maximizing problem:

(1) $$\max_{p_i} \pi_i^R = \sum_{i=1}^{n} (p_i^B - w_i^B - c_i) q_i^B$$

- where $c_i$ = the non-milk in-store marginal costs of retailing the product i
- $w_i^B$ = the wholesale price of the processed product i before the regulation
- $p_i^B$ = the retail price of the processed product i before the regulation
- $q_i^B$ = the demand curve as a function of $p_i^B$

# Pre-Regulation Retail Pricing with Retailer Price Leadership under Regulation

- The solution to the monopoly retailer's profit maximization problem is:

(2) $$P^B = \Omega^{B^{-1}} \Sigma^B (W^B + C)$$

where $$C = [c_i \quad \ldots \quad c_k]'$$

$$\Omega^B = \begin{bmatrix} s_1^B(1+\varepsilon_{11}^B) & \ldots & s_n^B \varepsilon_{1n}^B \\ \ldots & \ldots & \ldots \\ s_1^B \varepsilon_{n1}^B & \ldots & s_n^B(1+\varepsilon_{nn}^B) \end{bmatrix} \qquad \Sigma^B = \begin{bmatrix} s_1^B \varepsilon_{11}^B & \ldots & s_n^B \varepsilon_{1n}^B \\ \ldots & \ldots & \ldots \\ s_1^B \varepsilon_{n1}^B & \ldots & s_n^B \varepsilon_{nn}^B \end{bmatrix}$$

$$s_i^B = \frac{q_i^B}{Q}; \qquad \varepsilon_{ji}^B = \frac{\partial q_j^B}{\partial p_i^B} \frac{p_i^B}{q_j^B}$$

Q is the total quantity for the entire market

# Pre-Regulation Retail Pricing with Retailer Price Leadership under Regulation

- For one-brand case the standard markup rule is:

$$p^B = \frac{\varepsilon}{1+\varepsilon}(w^B + c) = \frac{1}{1+\frac{1}{\varepsilon}}(w^B + c)$$

where $\varepsilon < -1$

# Post-Regulation Retail Pricing with Retailer Price Leadership

- After a price collar policy is implemented, the retail price collar, k, is binding because the policy goal is to lower retail price. A monopoly retailer's profit maximization problem is now different. Define a new vector of prices $p_i^N = (1-\frac{1}{k})p_i = p_i - w_i$ . Now the firm's retail profit maximization problem can be restated in $p_i^N$ as follows:

(3) $$\max_{p_i^N{}_i} \pi_i = \sum_{i=1}^{n} (p_i^N - c_i)q_i$$

where $$p_i^N = \frac{k-1}{k} p_i$$

# Post-Regulation Retail Pricing with Retailer Price Leadership

- The solution to this new problem when $p_i^N$ is the new choice variable is:

(4) $$P^N = \Omega^{-1}\Sigma C$$

where $$P^N = [p_i^N \quad \ldots \quad p_n^N]'$$

$$\Omega = \begin{bmatrix} s_1(1+\varepsilon_{11}) & \ldots & s_n\varepsilon_{1n} \\ \ldots & \ldots & \ldots \\ s_1\varepsilon_{n1} & \ldots & s_n(1+\varepsilon_{nn}) \end{bmatrix} \qquad \Sigma = \begin{bmatrix} s_1\varepsilon_{11} & \ldots & s_k\varepsilon_{1n} \\ \ldots & \ldots & \ldots \\ s_1\varepsilon_{n1} & \ldots & s_n\varepsilon_{nn} \end{bmatrix}$$

$s_i = \frac{q_i}{Q}$ ; Q is the total quantity for the entire market

$$\varepsilon_{ji} = \frac{\partial q_j}{\partial p_i}\frac{p_i}{q_j}$$

# Post-Regulation Retail Pricing with Retailer Price Leadership

After substituting

$$p_i^N = \frac{k-1}{k} p_i$$

for i = 1, …, n, equation (4) becomes:

(5)

$$P = \frac{k}{k-1} \Omega^{-1} \Sigma C$$

For one-brand case one has:

$$p = \frac{k}{k-1} \frac{\varepsilon}{1+\varepsilon} c = \frac{1}{1-\frac{1}{k}} \frac{1}{1+\frac{1}{\varepsilon}} \quad ; \qquad \varepsilon < -1, k > 1$$

# Post-Regulation Retail Pricing with Retailer Price Leadership

- Insight: If one has estimated values of in-store marginal cost and supermarket own price elasticities of demand then one can simulate the post-regulation equilibrium prices and compare them to pre-regulation equilibrium prices.

# Pre- and Post-Regulation Prices with Retailer Price Leadership under Regulation

- The difference between the post-regulation and pre-regulation retail prices is equation (5) minus equation (2):

(6) $$P - P^B = \frac{k}{k-1}\Omega^{-1}\Sigma C - \Omega^{B^{-1}}\Sigma^B(W^B + C)$$

- If there is no change in any of the retail prices, the following condition holds:

(7) $$\varepsilon_{ij}^N = \frac{\partial Q_i}{\partial P_j^N}\frac{P_j^N}{Q_i} = \frac{\partial Q_i}{\partial P_j}\frac{\partial P_j}{\partial P_j^N}\frac{k-1}{k}\frac{P_j}{Q_i} = \frac{\partial Q_i}{\partial P_j}\frac{k}{k-1}\frac{k-1}{k}\frac{P_j}{Q_i} = \frac{\partial Q_i}{\partial P_j}\frac{P_j}{Q_i} = \varepsilon_{ij}^B$$

- Equation (7) indicates that if the retail prices before and after regulation are equal, then the own and cross demand elasticities before and after will also be the same.

# Pre- and Post-Regulation Prices with Retailer Price Leadership under Regulation

- Equating (6) to 0 and substituting (7) into it gives:

(8) $C = (k-1)W^B$

- Equation (8) can be met only if

(9) $\frac{c_i}{w_i^B} = k-1$ for all products, i = 1, …, n.

- If $\frac{c_i}{w_i^B} > k-1$, post-regulation retail price is higher.

- If $\frac{c_i}{w_i^B} < k-1$, post-regulation retail price is lower.

# Pre- and Post-Regulation Prices with Retailer Price Leadership under Regulation

- Given that retailers honor the constraint p = kw, the wholesale price and raw milk price after the regulation is implemented is:

(10) $$W = \frac{1}{k-1}\Omega^{-1}\Sigma C$$

- Assuming the pre-regulation ratio of wholesale and raw price is greater than m, if $w_i \geq w_i^B$ , then the post-regulation raw price is also higher. Since processors honor the second price collar, i.e. w = mr, the raw product price under the retailer leadership case is:

(11) $$R = \frac{1}{m(k-1)}\Omega^{-1}\Sigma C$$

# Post-Regulation Wholesale Pricing with Processor Price Leadership

- A processor's best response given that the retailer complies with the retail price collar may be different than the prior analysis of a retailer's best response given that processors comply with the wholesale price collar.
- One can specify a particular vertical game and derive some additional information about retail pricing because one then knows how retail and derived wholesale demand are related. Here we assume vertical Nash competition with its assumptions that

$$\frac{\partial p_i}{\partial w_i} = 1 \qquad \text{and} \qquad \frac{\partial p_i}{\partial w_j} = 0 \qquad \text{(Choi, 1991).}$$

# Post-Regulation Wholesale Pricing with Processor Price Leadership

- Under regulation retailers' compliance with the retail price collar gives the following derived inverse demand for a processor:

(14) $$w_i(q_i) = \frac{p(q)}{k}$$

- where q is a vector of demands for all products in the market. Given this demand specification we assume that each processor supplies only one brand and solves the following profit-maximization problem:

(15) $$\max_{w_i^N} \pi_i^m = (w_i^N - mc_i)q_i$$

- where $w_i^N = \frac{m-1}{m} - w_i$ and $mc_i$ is the non-raw-commodity marginal cost in producing product i. m is the processor price collar.

# Post-Regulation Wholesale Pricing with Processor Price Leadership

- We assume all producers pay the same raw commodity price. The solution to this post-regulation problem is:

$$(16) \qquad w_i = \frac{m}{m-1}\frac{\varepsilon_i}{1+\varepsilon_i} mc_i$$

- where $\varepsilon_i$ is the elasticity of demand at both wholesale and retail since they are related proportionally in (14).
- One can simulate wholesale prices using equation 16.

# Pre- and Post-Regulation Prices with Wholesaler Price Leadership under Regulation

- The post-regulation retail price is lower if equation (22) holds:

(22) $$\frac{km}{m-1} mc_i < r^B + mc_i + p_i^B - w_i^B$$

- The post-regulation wholesale price is higher when retail prices are lower, if:

(27) $$\frac{mc_i}{r^B} > m-1$$

# Pre- and Post-Regulation Prices with Wholesaler Price Leadership under Regulation

- Raw commodity price is higher after the regulation if $w_i > w_i^B$ and $\frac{w_i^B}{r_i^B} > m$ .

- The other case, $w_i > w_i^B$ and $\frac{w_i^B}{r_i^B} < m$ , will be ruled out because the policy goal is to raise raw price and thus $\frac{w_i^B}{r_i^B} > m$ is assumed.

# Post-Regulation Equilibrium

- A bargained equilibrium will lie within intervals:

$$p^L < p^* < p^H \text{ and } w^L < w^* < w^H, \quad r^L < r^* < r^H$$

where the superscripts L and H stand for high and low and * stands for the post-regulation bargained equilibrium. The bounds in these intervals are set by the retailer and processor solutions of the prior two sections. Either the retailer or processor will prefer the high price vector and the other will prefer the low price vector. If either a retailer or processor is dominant in the market channel, the equilibrium will be closer to its end of the range of possible price vectors.

# Application of the Model to the Southern New England Milk Market

- Figure 1:

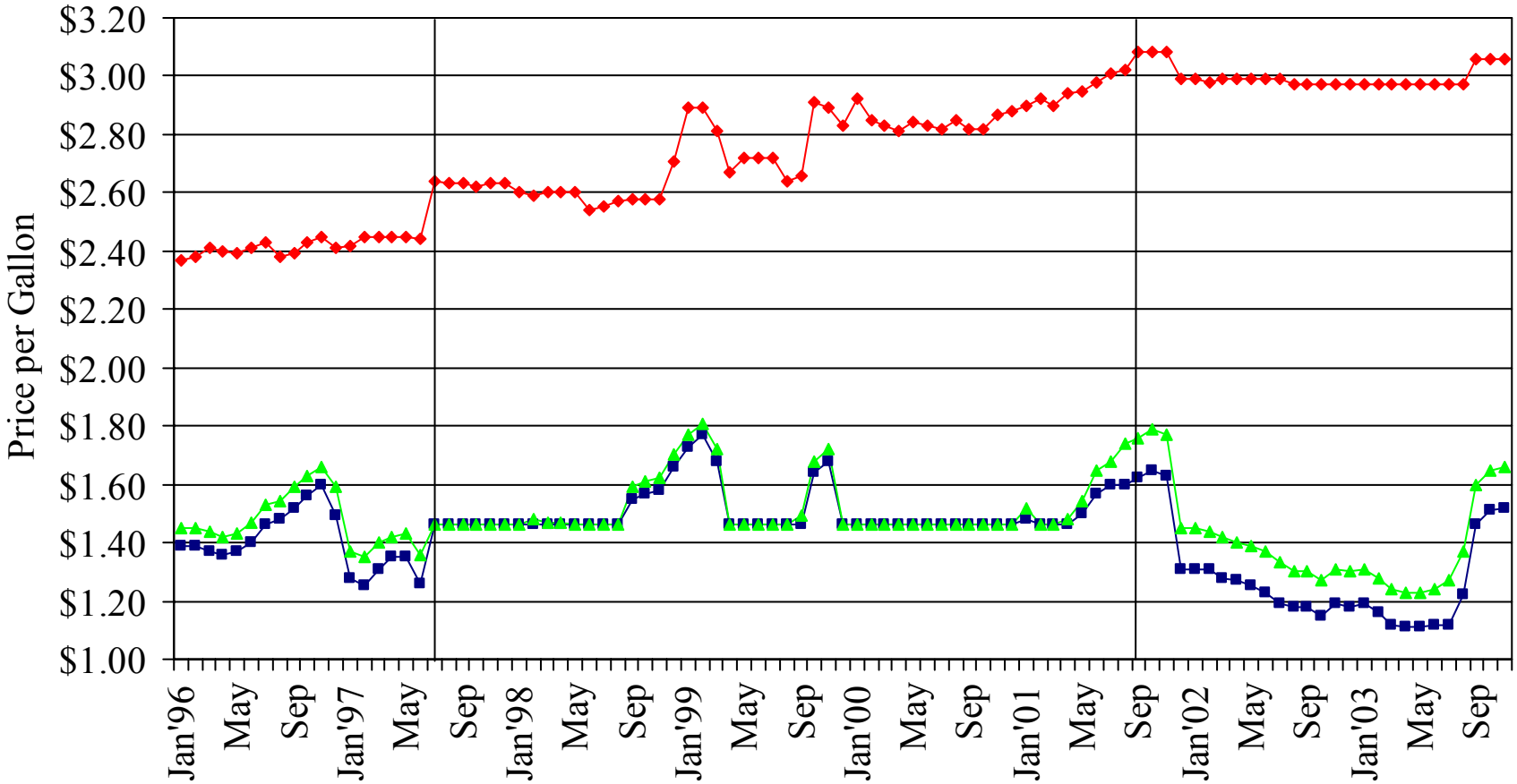
Boston
Market Level Retail and Farm Fluid Milk Price
January 1996 – November 2003

- Figure 2:

Actual Raw Milk, Estimated Wholesale,
and Actual Retail Milk Pricing by Brand
for the Four Leading Supermarket
Chains in Southern New England: June 2003

**Figure 1.**

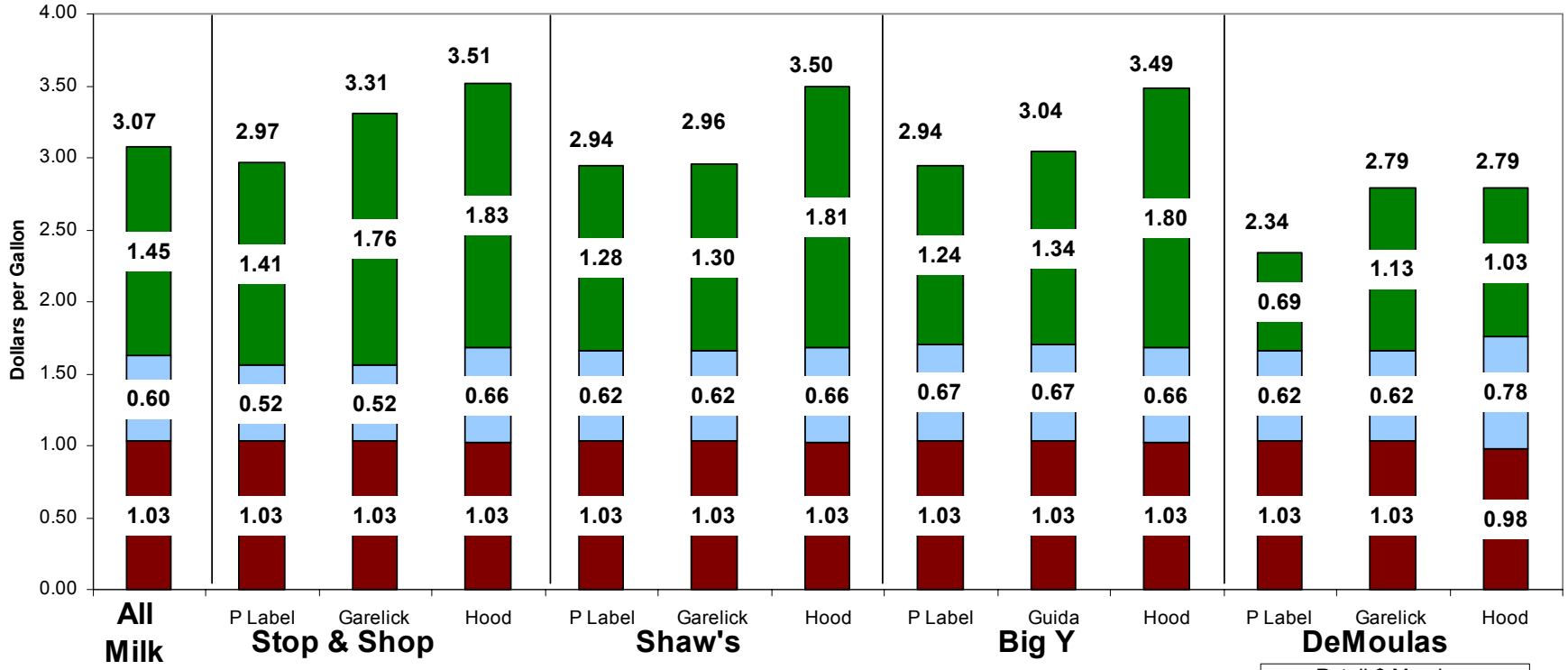
**Boston**
**Market Level Retail and Farm Fluid Milk Price**
**January 1996 – November 2003**




Source: Data from Order One Market Administrator and Dairy Market News

Vertical lines indicate beginning and end of Northeast Dairy Compact

# Figure 2: Actual Raw Milk, Estimated Wholesale, and Actual Retail Milk Pricing by Brand for the Four Leading Supermarket Chains in Southern New England: June 2003




Prices are the average across Whole, 2%, 1%, and Skim Milk and include all sales or promotional prices.
Wholesale $ Margin, from Dairy Technomics, includes Market Administrator Fee, Processor Assesment, and 1% Plant Loss.

# Application of the Model to the Southern New England Milk Market

- In Connecticut the proposed price collar law would allow a milk regulation board to set price collars. To date the debate has centered on a k = 1.3 retail price collar and a m = 1.4 wholesale price collar.
- For the retail leadership model the retail-pricing rule (9) predicts that if the non-milk marginal cost per gallon of selling milk is less than 30% of the pre-regulation wholesale price ($1.63), i.e. less than 48 cents, then retail price will drop. It is approximately 40 to 45 cents per gallon so retail price is predicted to decline.

# Application of the Model to the Southern New England Milk Market

- Since $\frac{p_i^B}{w_i^B} > 1.3$ wholesale prices are higher, and since $\frac{w_i^B}{r^B} > 1.4$ raw prices are also predicted to be higher.
- Given industry cost and pre-regulation price conditions under retailer leadership model the proposed price collars do move prices in desired or targeted directions.

# Application of the Model to the Southern New England Milk Market

- For the wholesale price leadership model equation (22) in fact holds for we have:

$$\frac{km}{m-1}mc_i = \frac{1.3*1.4}{0.4}0.45 < 1.00 + 0.45 + 3.10 - 1.63 = r^B + mc_i + p_i^B - w_i^B$$

or $2.05 < 2.92$

- This implies that in the processor leadership case retail price will also decline.
- The relevant condition to determine how wholesale price will change given retail prices declines is equation

(27): $\frac{mc_i}{r^B} = \frac{0.45}{1.00} < \text{or} > 0.4 = m - 1$ and one has $0.45 > 0.4$.

# Application of the Model to the Southern New England Milk Market

- Therefore post-regulation wholesale prices are higher than pre-regulation prices.
- Also since:

$$\frac{w_i^B}{r^B} = \frac{1.63}{1.0} > 1.40$$

  holds, raw prices are also higher.
- In conclusion under the processor leadership model the proposed price collar also move the prices in the desired or targeted direction.

# Application of the Model to the Southern New England Milk Market

- Turning now to the simulation results for the retailer leadership model. The pricing rule for simulating the retail price of a single "ALL MILK" product is

$$p = \frac{k}{k-1}\frac{\varepsilon}{1+\varepsilon}c$$

where $\varepsilon$ is own demand elasticity and c is in-store marginal cost for a retailer.

Table 1: Pre-Regulation Prices and Simulated Post-Regulation Retail, Wholesale, and Raw Milk Prices in the Retailer Leadership Model (Given k = 1.3, c = 0.45)

| Own Price Demand Elasticity | Post-Regulation Retail Price | Post-Regulation Wholesale Price | Post-Regulation Raw Price |
|---|---|---|---|
| 4.30 | 2.54 | 1.95 | 1.40 |
| 4.10 | 2.58 | 1.98 | 1.42 |
| 3.90 | 2.62 | 2.02 | 1.44 |
| 3.70 | 2.67 | 2.06 | 1.47 |
| 3.50 | 2.73 | 2.10 | 1.50 |
| 3.30 | 2.80 | 2.15 | 1.54 |
| 3.10 | 2.88 | 2.21 | 1.58 |
| 3.04* | 2.91 | 2.24 | 1.60 |
| 3.00 | 2.93 | 2.25 | 1.61 |
| 2.80 | 3.03 | 2.33 | 1.67 |
| 2.60 | 3.17 | 2.44 | 1.74 |
| Pre-Regulation Prices | 3.10 | 1.60 | 1.00 |

* Implied demand elasticity at retailing marginal cost of 45 cents.

Table 2: Pre-Regulation Prices and Simulated Post-Regulation Retail, Wholesale, and Raw Milk Prices in the Retailer Leadership Model (Given k = 1.28, c = 0.45)

| Own Price Demand Elasticity at Retail | Post-Regulation Retail Price | Post-Regulation Wholesale Price | Post-Regulation Raw Price |
|---|---|---|---|
| 4.30 | 2.68 | 2.06 | 1.47 |
| 4.10 | 2.72 | 2.09 | 1.49 |
| 3.90 | 2.77 | 2.13 | 1.52 |
| 3.70 | 2.82 | 2.17 | 1.55 |
| 3.50 | 2.88 | 2.22 | 1.58 |
| 3.30 | 2.95 | 2.27 | 1.62 |
| 3.10 | 3.04 | 2.34 | 1.67 |
| 3.04* | 3.07 | 2.36 | 1.68 |
| 3.00 | 3.09 | 2.37 | 1.70 |
| 2.80 | 3.20 | 2.46 | 1.76 |
| 2.60 | 3.34 | 2.57 | 1.84 |
| Pre-Regulation Prices | 3.10 | 1.60 | 1.00 |

* Implied demand elasticity at retailing marginal cost of 45 cents.

Table 3: Pre-Regulation Prices and Simulated Post-Regulation Retail, Wholesale, and Raw Milk Prices in the Retailer Leadership Model (Given k = 1.32, c = 0.45)

| Own Price Demand Elasticity | Post-Regulation Retail Price | Post-Regulation Wholesale Price | Post-Regulation Raw Price |
|---|---|---|---|
| 4.30 | 2.42 | 1.86 | 1.33 |
| 4.10 | 2.46 | 1.89 | 1.35 |
| 3.90 | 2.50 | 1.92 | 1.37 |
| 3.70 | 2.54 | 1.96 | 1.40 |
| 3.50 | 2.60 | 2.00 | 1.43 |
| 3.30 | 2.66 | 2.05 | 1.46 |
| 3.10 | 2.74 | 2.11 | 1.51 |
| 3.04* | 2.77 | 2.13 | 1.52 |
| 3.00 | 2.78 | 2.14 | 1.53 |
| 2.80 | 2.89 | 2.22 | 1.59 |
| 2.60 | 3.02 | 2.32 | 1.66 |
| Pre-Regulation Prices | 3.10 | 1.60 | 1.00 |

* Implied demand elasticity at retailing marginal cost of 45 cents.

Table 4: Pre-Regulation Prices and Simulated Post-Regulation Retail, Wholesale, and Raw Milk Prices in the Retailer Leadership Model (Given k = 1.3, c = 0.40)

| Own Price Demand Elasticity | Post-Regulation Retail Price | Post-Regulation Wholesale Price | Post-Regulation Raw Price |
|---|---|---|---|
| 4.20 | 2.28 | 1.75 | 1.25 |
| 4.00 | 2.31 | 1.78 | 1.27 |
| 3.80 | 2.35 | 1.81 | 1.29 |
| 3.60 | 2.40 | 1.85 | 1.32 |
| 3.40 | 2.46 | 1.89 | 1.35 |
| 3.20 | 2.52 | 1.94 | 1.39 |
| 3.00 | 2.60 | 2.00 | 1.43 |
| 2.90* | 2.65 | 2.04 | 1.45 |
| 2.80 | 2.70 | 2.07 | 1.48 |
| 2.60 | 2.82 | 2.17 | 1.55 |
| 2.40 | 2.97 | 2.29 | 1.63 |
| Pre-Regulation Prices | 3.10 | 1.60 | 1.00 |

* Implied demand elasticity at retailing marginal cost of 40 cents.

# Application of the Model to the Southern New England Milk Market

- Turning now to the processor leadership simulation model wholesale equilibrium prices are obtained from equation (16):

$$w_i = \frac{m}{m-1}\frac{\varepsilon_i}{1+\varepsilon_i} mc_i$$

Table 5: Pre-Regulation Prices and Simulated Post-Regulation Retail, Wholesale, and Raw Milk Prices in the Processor Leadership Model (Given k = 1.3, m = 1.4, mc = 0.45)

| Own Price Demand Elasticity at Wholesale | Post-Regulation Retail Price | Post-Regulation Wholesale Price | Post-Regulation Raw Price |
|---|---|---|---|
| 11 | 2.27 | 1.73 | 1.25 |
| 10 | 2.29 | 1.75 | 1.26 |
| 9.06* | 2.30 | 1.77 | 1.26 |
| 8 | 2.34 | 1.80 | 1.27 |
| 7 | 2.39 | 1.84 | 1.28 |
| 6 | 2.46 | 1.89 | 1.3 |
| 5 | 2.56 | 1.97 | 1.31 |
| 4 | 2.73 | 2.10 | 1.50 |
| 3 | 3.07 | 2.36 | 1.69 |
| 2.5 | 3.41 | 2.63 | 1.88 |
| Pre-Regulation Prices | 3.10 | 1.60 | 1.00 |

* Implied demand elasticity at processing marginal cost of 45 cents.

# Summary and Conclusion

- The theory of price collars developed in this paper links raw product, wholesale and retail prices in a three-stage channel.
- Analysis of retail and processor conduct before and after price collar regulation allows us to determine the conditions that must be met if a particular regulatory regime is to change retail, wholesale, and raw product prices in particular direction.

# Summary and Conclusions

- We analyze the vertical pricing problem as either retailer or processor leadership and derive the equilibrium price vectors for both.
- They are a function of the price collars, marginal costs, and demand elasticities.
- When we simulate the theory for the fluid milk market in Southern New England we discover a result that clearly demonstrates retailer dominance.
- The regulation agency can attain different price targets by changing the price collar value.