Retail Oligopoly Power and Fluid Milk Prices in Boston

Benaissa Chidmi, Rigoberto A. Lopez, and Ronald W. Cotterill
Department of Agricultural & Resource Economics,
University of Connecticut
1376 Storrs Rd., CT 06269
Phone (860) 486-1921
Benaissa.2.chidmi@uconn.edu or *rlopez@canr.uconn.edu*

Abstract

This paper assesses the independent and joint impacts of oligopoly power of market intermediaries and the Northeast Dairy Compact (NEDC) on fluid milk prices in Boston. Empirical results reveal that price increases due to oligopoly power far outweighed those caused by the NEDC by more than 10 times. In fact, markups are estimated at approximately 33% of the retail milk price, translating into approximately $1/gallon overcharge at 2002 milk prices averaging around $3/gallon.

Paper Prepared for presentation at the American Agricultural Economics Association Annual Meetings, Montreal, Canada, July 27-30, 2003

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1. Introduction

Market power, the ability of firms to control market price or quantity, often coexists with other market imperfections. Allegations of market power in the Boston milk market stems from observed increases in concentration in processing and retailing as well as from retail milk prices that are higher than in neighboring states. In addition, other market distortions stem from recent public policies that affect raw milk prices, such as the Northeast Dairy Compact (NEDC) and, more recently, federal subsidies based on the Class I milk price in Boston.[1]

For policy analysts, an important question when evaluating the independent impacts of market power or public policies is whether or not the presence or absence of the other distortions should be taken into account. That is, should impacts be evaluated in a first-best or second-best world? The relevant policy question depends on a policy maker's degrees of freedom in eliminating market imperfections.

The Boston fluid milk market provides a useful case study. First, public policies have stirred a hot debate in policy and research arenas, particularly regarding the NEDC which controlled supply in order to support raw milk prices.[2] These policies have co-existed with increasingly concentrating processing and retailing sectors that have also raised market power concerns. Nonetheless, amid critics and economic interests of leading milk-producing states, the NEDC was dismantled in September 2001. Now that the NEDC is gone, the issue of high retail milk prices and markups in the Boston area remain in the spotlight. Furthermore, the newly created National Dairy Program that relies on the Class I Boston price raises the stakes of the potential impact of the oligopoly behavior of retailers (which would curtail volume sales to attain higher prices) on raw milk prices in the Boston area and beyond.[3] Ironically, the zero cost to taxpayers of the NEDC has been replaced by a program paid for by taxpayers that will benefit processors, dairy producers at the national level and to some extent New England dairy farmers (relative to the alternative of no program at all) and consumers (to the extent that the cost savings are passed onto them).

This paper assesses the joint and independent impacts of oligopoly power of processors and retailers and of the NEDC on retail milk prices and markups in Boston. The paper draws from the model of Appelbaum (1982) to measure departures from competitive behavior and the impact of the NEDC on markups. Empirical findings indicate that although the NEDC increased the retail price of milk by 7.9 cents per gallon under pre-existing oligopoly power, the increase in consumer prices due to oligopoly power is more than 10 times that amount. Findings indicate that approximately 33% of the retail price is due to oligopoly power, translating to approximately a $1/gallon overcharge at current milk retail prices of about $3/gallon.[4]

2. The Boston Fluid Milk Market

The Boston fluid milk market provides an interesting case study for a number of reasons. In particular, it has undergone significant changes in both market structure and raw milk policy programs.

In addition to being subject to regulation through the NEDC from July 1997 through September 2001, at the processor level, the market share of the top four fluid milk processors in the Boston area increased from 66 percent to 88 percent between 1997 and 1999 (GAO, June 2001). This increase in concentration is mainly the result of mergers and acquisitions.[5]

At the retail level, the market share of the four top supermarkets (Stop & Shop, Shaw's, DeMoulas, and Star Market) in the Boston area increased from 55 percent to 70 percent between 1997 and 1999 (GAO, June 2001). By July 2000, these supermarkets controlled more than 84 percent of fluid milk sales (Table1). The retailers are the dominant players. First, their private label milk accounts for more than 68 percent of total milk sales. Second, their position in the chain makes them the ultimate-pricing makers. Third, their prices appear to be highly coordinated. Using the four-weekly data from Information Resources Incorporated-Infoscan (IRI), the partial correlation coefficient of the retail milk prices for these supermarkets ranges from 0.94 to 0.98, and thus move together to a great extent as shown in figure 1.

Table 1: Characteristics of the Milk Retailers in Boston

	Stop & Shop	Shaw's	DeMoulas	Star Market	Others
Milk Market Share (%)	27.04	20.50	18.44	12.71	21.31
Grocery Market Share	30.67	16.75	12.52	13.58	26.48
In-Store Private Label Milk Share (%)	68.07	68.78	87.48	48.94	na
Square Footage	83.44	40.90	40.59	38.18	20.99

Source: IRI (1996-2000) and Trade Dimensions (1998).

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3. The Model

Consider a fluid milk industry in which *N* firms produce and distribute a homogeneous good. Each firm is assumed to be vertically integrated into processing and retailing milk. Total industry output is given by $Q = \sum_{i=1}^{N} q_i$, where q_i is the level produced by firm *i*.

Let the market demand facing the industry be given by:

$$Q = f(p_r, Z), \qquad (1)$$

where p_r is the retail price of milk and Z is a vector of demand shifters.

The variable profits made by the i[th] retailer/processor are given by:

$$\pi_i = pq_i - p_f q_i - C_i(q_i, w), \tag{2}$$

where p_f is the farm price and $C_i(q_i, w)$ is the cost of processing and distributing milk incurred by the i[th] firm, and w is a vector of prices for non-milk inputs in processing and distribution activities.

The first order condition for maximization of (2) yields:

$$p_r = \frac{p_f + MC_i}{1 + \frac{\theta_i}{\eta}}, \tag{3}$$

where θ_i is a conjectural variation elasticity $(= \partial \ln Q / \partial \ln q_i)$ and η is the price elasticity of market demand $(= \partial \ln Q / \partial \ln P_r)$. Note that the marginal cost has two components: the milk marginal cost P_f and the non-milk marginal cost MC_i. The larger θ_j or the lower η (in absolute value) is, the wider will be the markup over marginal cost or the spread between retail price and farm price.

To infer market power with market level data, two problems arise from equation (3): the aggregation of non-milk marginal cost MC_i and the aggregation of conjectural variation elasticities across firms. We specify a Gorman polar form so that marginal costs are constant across firms without implying that cost functions are identical for all firms: $MC_j = MC$. Then, as long as the assumption of constant total marginal cost is maintained, at equilibrium the conjectural elasticities are the same for all retailers $(\theta_j = \theta)$.

With these assumptions, industry equilibrium is depicted by:

$$p_r = \frac{p_f + MC}{1 + \frac{\theta}{\eta}}. \tag{4}$$

Under perfectly competitive behavior $\theta = 0$, and the retail price equals marginal cost. As the conjectural variation elasticity increases, the markup over marginal cost increases. The null hypothesis to be tested concerns the market conduct parameter θ and its deviation from perfect competition as well as any changes in conduct due to implementation of the NEDC.

In order to evaluate the impact of the implementation of NEDC, the parameter θ is allowed to vary with a NEDC dummy variable. Assuming a linear non-milk marginal cost function with *m* inputs purchased at fixed prices $w_i (i = 1, \ldots, m)$, equation (4) becomes:

$$p_r = \frac{p_f + \sum_{i=1}^{m} \beta_i w_i}{1 + \frac{(\theta_0 + \theta_1 NEDC)}{\eta}}, \tag{5}$$

where β_i, θ_0 and θ_1 are parameters to be estimated.

The market demand function (1) faced by retailers is assumed to take the double logarithmic form given by

$$\ln Q = \alpha_0 + \eta \ln(p_r / d) + \sum_{i=1}^{n} \alpha_i Z_i, \tag{6}$$

where $\ln$ indicates the natural logarithm operator, Q is the total quantity of fluid milk, d is a price deflator, Z_i denotes demand shifters, and the α's and η are parameters to be estimated.

To determine the impacts of oligopoly power and the NEDC, it is necessary to separate out the two effects. To do so, one can decompose equation (5) into four scenarios:

Table 2. Retail Price for Fluid Milk under Alternative Scenarios

	Oligopoly	Perfect Competition
NEDC	A: $p_r = \dfrac{p_f + NMMC}{1 + \dfrac{(\theta_0 + \theta_1 NEDC)}{\eta}}$	B: $p_r = p_f + NMMC$
No NEDC	C: $p_r = \dfrac{p_f^* + NMMC}{1 + \dfrac{\theta_0}{\eta}}$	D: $p_r = p_f^* + NMMC$

p_f^* represents the farm level price in the absence of the NEDC, $NMMC = \sum_{i=1}^{m} \beta_i w_i$ is the non-milk marginal cost

Scenario A illustrates the actual situation with simultaneous distortion of retail oligopoly power and the NEDC. Under competitive pricing with the absence of the NEDC, the retail price is equal to the total marginal cost, which includes the raw milk price and the cost of processing and distributing milk. Departure from the competitive price implies that there is a markup above total marginal cost. Scenario C illustrates the impact of the oligopoly market power on the retail price of fluid milk in the absence of the NEDC. Similarly, scenario B illustrates the impact of the implementation of the NEDC on retail prices for fluid milk when the market is competitive.

4. Data and Estimation

Equations (5) and (6) are the basis for empirically assessing the market power of fluid milk processors/retailers in the Boston fluid milk market and the impact of the NEDC.

The model is estimated with data from the Boston milk market. The core data came from the Information Resources Incorporated-Infoscan (IRI) database provided by the Food and

Marketing Policy Center at the University of Connecticut. It includes 58 four-week-ending observations covering the period from March 1996 to July 2000. The IRI data provided the values of fluid milk sales by each supermarket chain, the volume sold, and the percentage of fluid milk sold through promotions and merchandising. The retail milk price was computed by dividing total dollar sales by total volume.

Regarding input costs, the farm level milk price is the most important cost in retail packaged fluid milk. The Federal Milk Market Order announced Class I price was used to measure P_f. Wage rate ($/hour) data was used in the non-milk cost function specification. The Boston area wage rate for food manufacturing was obtained from the website of the Bureau of Labor Statistics. Other non-milk input costs (i.e., a national price index for the price of energy) had to be excluded due to multicollinearity and pervasive results. Additional demand function data included per capita income, the price of orange juice (as a complement/substitute good), and the percentage of fluid milk sold under promotion. Prices and income in the demand equation were deflated by the consumer price index for Boston.

The system of equations in (5) and (6) is recursive, nonlinear in parameters, and has a cross-parameter restriction (η). The system of equations was estimated using the Generalized Method of Moments (GMM). The GMM estimation method introduced by Hansen (1982) goes beyond the non-linear two-stage least squares method of Amemiya (1974) in that it incorporates nonlinear moment conditions beyond moment conditions generated by orthogonality of instrumental variables and disturbances in a model (Lee, 2001).

5. Empirical Results

The parameter estimates for equations (5) and (6) are summarized in Table 3. The results indicate that the conjectural variation elasticity estimate $(\hat{\theta}_0 + \hat{\theta}_1 = 0.1229)$ is significantly different from zero at the 5% level, meaning that market conduct is not perfectly competitive. On the other hand, the hypothesis that $\theta_0 + \theta_1 = 1$ was also rejected, meaning that the processors/ retailers are not perfectly collusive either.

Although the first term of the conjectural variation elasticity (θ_0) is positive and significant at the 5% level, the second term (θ_1) is positive but not significantly different from zero (at the 5% level). This result suggests that the NEDC did not have a discernable effect on the conjectural variation elasticity. This does not mean that market conduct was any more competitive after the NEDC implementation. Rather, pricing conduct continued mostly at the pre-existing level and markups did not significantly increase.

The computed Lerner index $(L = 0.3295)$ is significantly different from zero at the 5% level. The value of the Lerner index suggests that the processors/retailers do exert a significant degree of oligopoly power by setting fluid milk retail prices above the level dictated by competitive pricing. The markup over the marginal cost, which serves as the competitive benchmark, is approximately one-third of the retail milk price. At current milk prices of about $3/gallon, this translates approximately a $1/gallon overcharge.

The impact of the implementation of the NEDC is determined by means of derivation of the equation (5) with respect to the NEDC variable.[6] The results show that the total effect in the Boston milk market of the Compact is an increase in the retail price of milk of 7.9 cents per gallon.

In comparison, Bailey (2000) concluded that the NEDC's impact raised retail milk prices 14 cents per gallon, while Cotterill and Franklin (2001) found the impact to be a 4.5 cents per gallon increase. Dhar (2001) found price increases ranging from 7 cents per gallon for Hood milk to 17 cents for private label milk after the implementation of the Compact. Thus, the magnitude of the price increase found in this paper is in the range of those in previous studies.

Besides differences in the magnitudes of the increase in retail milk prices due to the Compact, stark differences remain in the interpretation of the sources of the increase. Bailey (2000) asserts the Compact is responsible for the full increase in prices, taking industry markups as given and exonerating processors and retailers It should be noted that the findings of this paper do support Bailey's methodology in that percent markups did not change with the Compact. Cotterill and Franklin (2001) argue that under price certainty equivalence, the Compact should have raised prices at most 4.5 cents per gallon and should have induced a lower increase in consumer prices due to price stability. They put the blame on processors and retailers for retail price increases. Dhar (2001) attributes these margin widening increases to more collusive market conduct after implementation of the Compact.

Figure 2 depicts the actual Boston milk prices and the estimated prices, which would prevail if the Boston milk market segment were perfectly competitive. The gap represents overcharge attributed to the estimated oligopoly power of processors and retailers. The average overcharge is about $0.86/gallon or $0.92/gallon in constant July 2000 dollars (using the Boston consumer price index as a deflator). Although the NEDC captured much of the media, political and academic alteration, it is worth noting that estimated overcharges attributed to the NEDC pale in comparison to the oligopoly overcharges found in this study. The estimated oligopoly markup is more than 10 times the size of the price increase attributed to the NEDC price increase.

The empirical results further show that the price elasticity of demand for milk at the retail level in Boston is estimated at approximately -0.375, illustrating that fluid milk demand is inelastic. The estimate derived here is consistent with estimates presented by Johnson, Stonehouse and Hassan (1992). The low elasticity of demand also corroborates the large potential oligopoly power of the processors and retailers as current consolidation trends continue.

6. Concluding Remarks

In conclusion, the findings reported in this paper strongly support the notion that retailers/processors do exert a significant degree of oligopoly power in the Boston fluid milk market. They reveal that price increases due to oligopoly power have far outweighed those caused by the Northeast Dairy Compact. Oligopoly generated markups are estimated at approximately 33% of the retail milk price, translating into approximately a $1/gallon overcharge at current milk prices averaging around $3/gallon. The results also show that after the implementation of the Northeast Dairy Compact retail milk prices increased by 7.9 cents, with 3.4 cents of that increase due to oligopoly power. The Northeast Dairy Compact did not significantly change pricing behavior or percent mark ups in the Boston fluid milk markets.

Ultimately, the findings of this study illustrate that inclusion of market power by intermediaries should be consistent when designing a more comprehensive dairy policy program. Assuming that processing and retailing channels are perfectly competitive can lead to deceptive equity and efficiency conclusions regarding programs that purport to assist dairy farmers and help consumers.

Footnotes

[1] In July 1997, the Northeast Dairy Compact (NEDC) was created with the presumption that it would have several desirable social benefits, including providing stable farm prices for small family farms without the infusion of federal tax dollars (Bailey, 2001). Researchers and policy makers alike raised major questions concerning the impact of the Compact on consumers, i.e., the retail price of fluid milk. This paper will not deal with positive externalities arising from open space in dairy lands in the greater Boston area (Lopez, Altobello, and Shah, 1994) or with potential spillover price effects to producers in other regions (Bailey, 2001).

[2] Researchers have taken several avenues of inquiry and have reached contradictory empirical results. One set of studies focuses on asymmetric price transmission, assuming a competitive milk marketing channel (e.g., Lass et al., 2001); another set of studies specifies rather than estimates a proportional markup in a simulation model framework (e.g., Bailey, 2000); and yet another set of studies compares prices, margins and costs before and after the NEDC (Cotterill and Franklin, 2001). Dhar (2001) uses a vertical Nash game at the brand level in the Boston market and introduces the compact as a dummy variable in the pricing equation. Cotterill (2002) reviews and critiques these studies.

[3] This 3 ½ year program provides a federal payment to producers each month equal to 45% of the difference between $16.94 and the Boston Class I price. Payments are made on up to 2.4 million pounds of production per year to a producer anywhere in the U.S. The estimated cost of this program is approximately $1 billion.

[4] A state hearing on November 12, 2002 in Boston turned up evidence that the region's largest dairy processors and supermarket chains may be earning large profits on milk or more than $1/gallon (Mohl, 2002).

[5] As an example of merger and acquisition, Suiza Foods Corporation acquired in 1997 Garelick Farms and Franklin Plastics, a local fluid milk processor. According to Cotterill (2001), Suiza Foods Corporation process most brands including Garelick, Sealtest, and the store brands of Wal-Mart and nearly all supermarkets except Big Y and Shoprite.

[6] The impact of the implementation of the NEDC is determined by deriving the following decomposition based on equation (5).

$$\frac{\Delta P_r}{\Delta NEDC} = \frac{\partial MC^T}{\partial P_f}\frac{\Delta P_f}{\Delta NEDC} + \frac{\partial MC^T}{\partial P_f}\frac{\Delta P_f}{\Delta NEDC}\frac{L}{1-L} + \frac{\partial P}{\partial \theta}\frac{\Delta \theta}{\Delta NEDC}$$

where MC^T is the total marginal cost $(P_f + NMMC)$. The simulation is conducted for an increase of 4.5 in the raw milk price due to the Compact (Cotterill and Franklin, 2001). The first term is estimated at 4.5 cents, the second term at 2.2 cents and the third term at 1.2 cents. The sum of the last two terms (3.4 cents or 43% of the total increase) is attributed to oligopolistic market power. Our findings are consistent with state policy makers' concerns.

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Table 3. Parameter Estimates for Pricing and Demand Equations in the Boston Milk Market.

Variable	Parameter	Coefficient	T-Ratio
Pricing Equation:			
Pre-NEDC Conj Var. El.	θ_0	0.1179**	2.2041
NEDC Dummy	θ_1	0.0059	1.0205
MC Constant	β_0	7.0908***	7.2508
Wage	β_1	0.2195***	5.9714
Elasticity of demand	η	-0.3754***	-3.0304
Demand Equation:			
Constant	α_0	7.9991***	9.1400
Elasticity of Demand	η	-0.3754***	-3.0304
Log of Income	α_1	-0.7608***	-6.8527
Log of Orange Juice Price	α_2	-0.1360***	-2.2606
Log of % Promotion Sales	α_3	0.0218**	2.1840
Lerner Index (Post NEDC)	$-\frac{(\theta_0+\theta)}{\eta}$	0.3295***	3.3057

Notes: Two and three asterisks indicate significance at the 5 and 1 percent levels, respectively. N=58 four-weekly observations between March 1996 and July 2000.

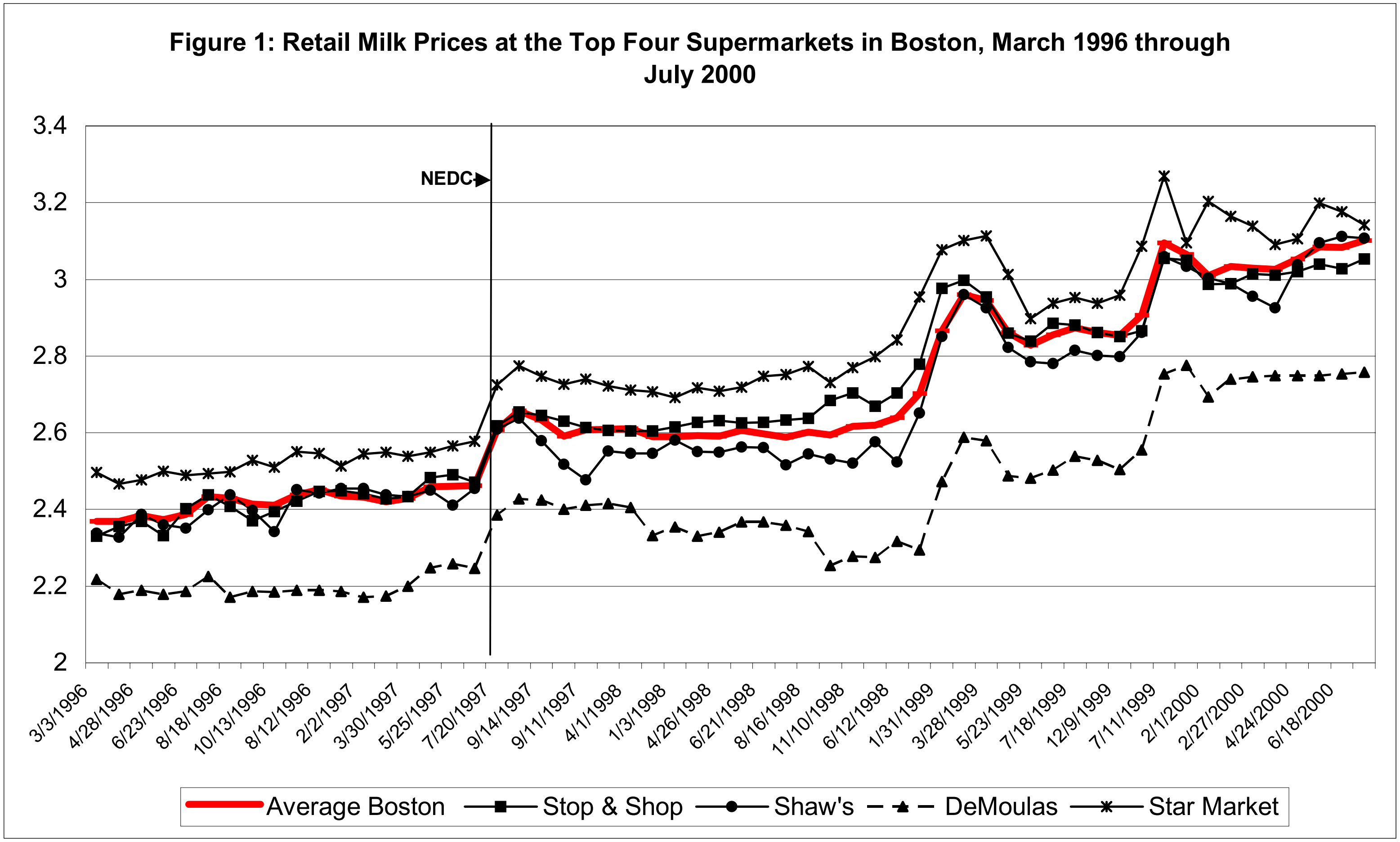
Figure 1: Retail Milk Prices at the Top Four Supermarkets in Boston, March 1996 through July 2000
3.4
3.2
3
2.8
2.6
2.4
2.2
2
NEDC
3/3/1996
4/28/1996
6/23/1996
8/18/1996
10/13/1996
8/12/1996
2/2/1997
3/30/1997
5/25/1997
7/20/1997
9/14/1997
9/11/1997
4/1/1998
1/3/1998
4/26/1998
6/21/1998
8/16/1998
11/10/1998
6/12/1998
1/31/1999
3/28/1999
5/23/1999
7/18/1999
12/9/1999
7/11/1999
2/1/2000
2/27/2000
4/24/2000
6/18/2000
Average Boston
Stop & Shop
Shaw's
DeMoulas
Star Market

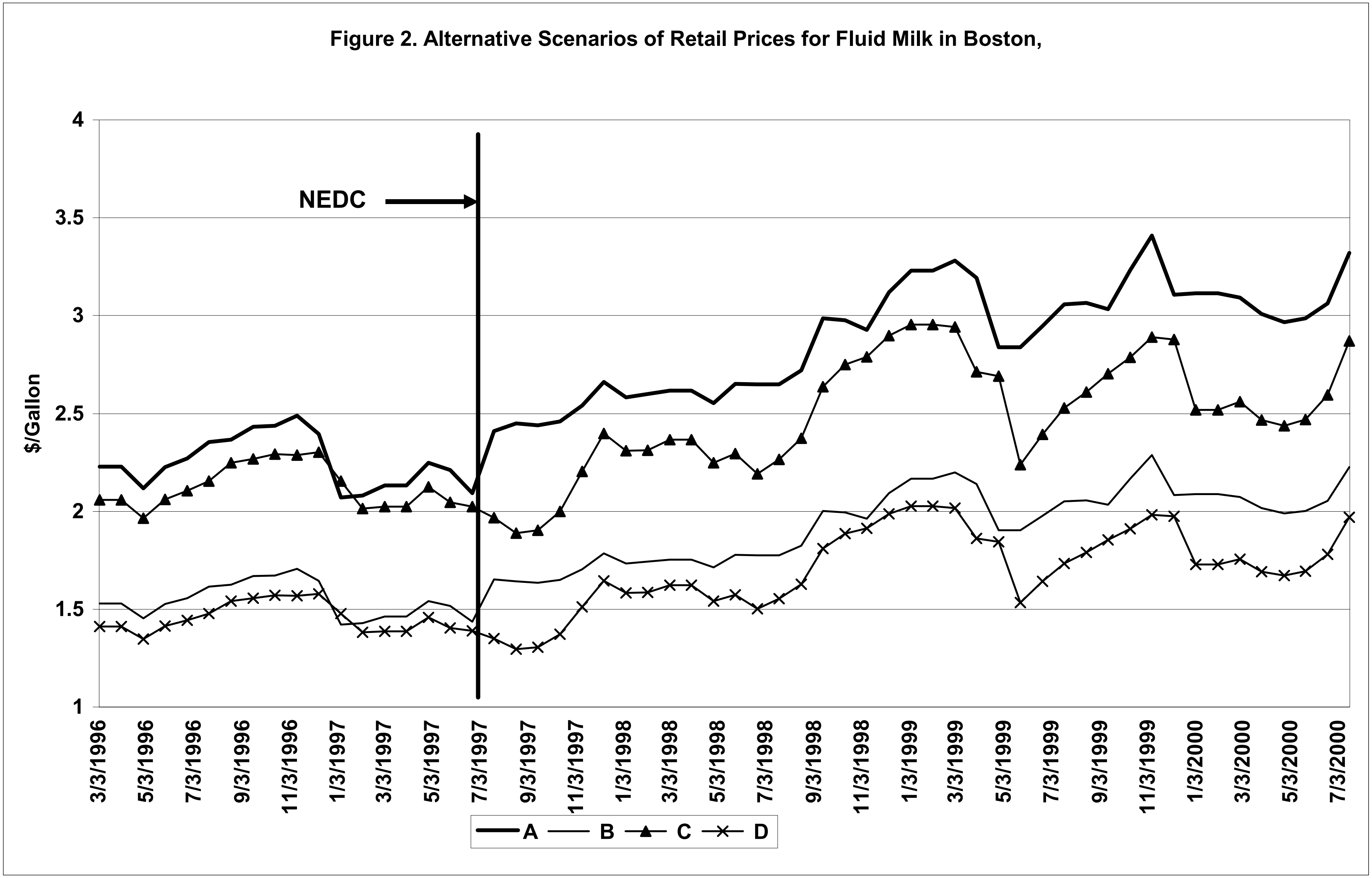

Figure 2. Alternative Scenarios of Retail Prices for Fluid Milk in Boston,
NEDC
$/Gallon
4
3.5
3
2.5
2
1.5
1
3/3/1996
5/3/1996
7/3/1996
9/3/1996
11/3/1996
1/3/1997
3/3/1997
5/3/1997
7/3/1997
9/3/1997
11/3/1997
1/3/1998
3/3/1998
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7/3/1999
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1/3/2000
3/3/2000
5/3/2000
7/3/2000
A
B
C
D