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# Impacts of the Northeast Interstate Dairy Compact on the WIC Program: Evidence from Boston and Hartford

**Qingbin Wang, Zooyob Anne, Catherine Halbrendt, Charles Nicholson, and Jaimie Sung**

This paper examines the impacts of the Northeast Interstate Dairy Compact (Compact) on the Women, Infants and Children (WIC) program using an autoregressive-moving average (ARMA) model and data from Boston and Hartford. While the results for Boston indicate that the difference between the net fluid milk price paid by WIC program and the forecasted fluid milk price with no Compact in effect was not significant over the period of July 1997 to June 1998, the results for Hartford suggest that the net price paid by WIC was significantly greater than the forecasted price with no Compact in effect over the same period. A similar analysis of the changes in markups suggests that the increase in the net fluid milk price paid by the WIC program in Hartford was largely due to increased markups.

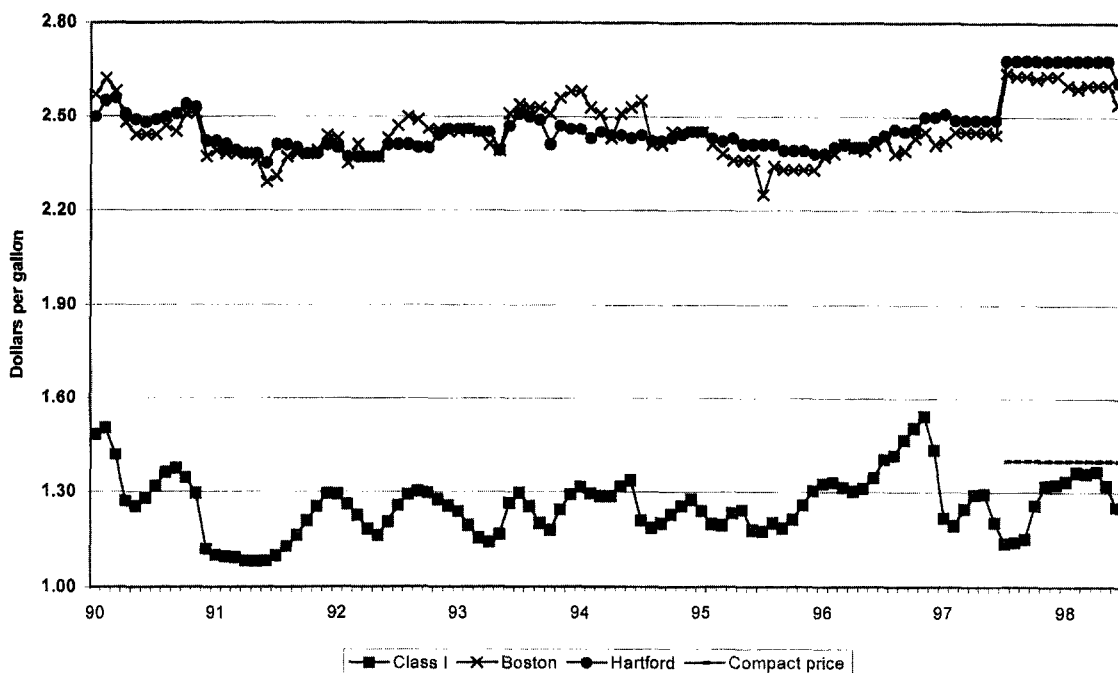
The Northeast Interstate Dairy Compact (Compact), as the first regional dairy compact in the U.S., has been the focus of a great deal of attention and speculation since its inception in July 1997 (Bailey and Gamboa 1999; Knutson 1999). Debates on renewal of the Compact have centered on whether the Compact has kept retail milk prices artificially high and whether it has really slowed down the disappearance of dairy farms in the New England region (Machacek 1999). To accomplish its goals, the Compact has stabilized the price paid by fluid milk processors at \$1.40 per gallon since July 1997 through a variable Compact over-order premium (see figure 1). Although the Compact has helped many farmers in the region, some observers associate it with increases in retail milk prices in the post-Compact period, especially in July 1997. Figure 1 indicates that retail milk prices in Boston and Hartford increased by about \$0.20 per gallon at the start of the Compact and then remained at levels higher than those observed in previous years. Such increases in retail milk prices have brought about concerns from consumers and policymakers. Retail milk price increases can have negative ef-

fects on consumer welfare and can result in changes in government programs such as the Women, Infants and Children (WIC) program. This study examines the impacts of the Compact on the WIC program using data from Boston and Hartford.

The WIC program was established in September 1972 to prevent anemia and inadequate growth that were common among children of low-income families. This federal program was designed to improve the health status of participants by (i) assuring access to health care and social welfare programs, (ii) teaching families nutritional practices, and (iii) providing individually-designed nutritious food packages. Eligibility for the WIC program is based on residence, age, maternity status, income, and medical or nutritional need. Fluid milk has been a major food item of the WIC program. According to an estimate of the Food and Nutrition Service of the USDA, WIC programs nationwide spent an average of 30% of their food budgets on fluid milk in 1996.

The Compact was established as the result of a provision of the 1996 Farm Bill. According to the provision, the Northeast Interstate Dairy Compact Commission reimburses the WIC programs in the Compact states by the amount of the Compact over-order premium. This provision was designed to prevent any increase in the net price paid for

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**Figure 1. Monthly Class I, Compact, and Retail Milk Prices in Boston and Hartford**

fluid milk by WIC programs in the Compact states. However, because most WIC programs in New England allow participants to purchase fluid milk directly from retail stores, the net price paid by WIC programs depends on both the Compact over-order premium and any related changes in the retail price. The net price paid by the WIC program will not be affected only if the change in retail milk price is equal to the Compact over-order premium. This is unlikely because changes in the retail fluid milk price are determined by many other factors such as transportation and processing costs that affect wholesaler and retailer markups.

Any increase in the cost of fluid milk would increase the food package costs for WIC programs.

This could possibly result in a reduction in the number of WIC program participants and/or a change in the composition of food packages. As shown in table 1, the number of WIC participants in the six Compact states dropped slightly from 257,566 persons in June 1997 to an average of 256,894 in the next three months (July–September 1997), but then increased to an average of 266,844 during October 1997 to February 1998. While the number of WIC participants decreased slightly in Maine, New Hampshire, and Rhode Island during July 1997 to February 1998 and increased in Vermont, Massachusetts, and Connecticut in the same period, the total number of participants in these six states increased slightly to an average of 263,113

**Table 1. The Number of WIC Participants in the Compact States from June 1997 to February 1998**

| Year | Month     | States |       |        |       |       |       | All Compact States |
|------|-----------|--------|-------|--------|-------|-------|-------|--------------------|
|      |           | CT     | ME    | MA     | NH    | RI    | VT    |                    |
| 1997 | June      | 57756  | 26737 | 114573 | 19365 | 22967 | 16168 | 257566             |
|      | July      | 59013  | 26572 | 113663 | 19079 | 22739 | 16232 | 257298             |
|      | August    | 60752  | 26423 | 111906 | 19140 | 22567 | 16197 | 256985             |
|      | September | 60738  | 26359 | 111311 | 18952 | 22628 | 16411 | 256399             |
|      | October   | 62550  | 25395 | 121555 | 18960 | 22867 | 16452 | 267779             |
|      | November  | 62680  | 26382 | 121300 | 18737 | 21725 | 16329 | 267153             |
| 1998 | December  | 62253  | 26152 | 120907 | 18632 | 21951 | 16361 | 266256             |
|      | January   | 62986  | 26119 | 122505 | 18817 | 22697 | 16337 | 269461             |
|      | February  | 59210  | 25786 | 120915 | 18605 | 22712 | 16345 | 263573             |

for the July 1997 to February 1998 period. Although these changes may be due to other factors, they suggest that milk price regulation under the Compact has not had any dramatic effect on the number of WIC participants. Due to data limitations, possible changes in the composition of food packages of the WIC programs are not examined in this study.

The main purpose of this study is to assess the possible impacts of the Compact on the WIC program. Specifically, this paper first examines whether there has been any significant change in the net fluid milk price paid by WIC programs in the post-Compact period using retail fluid milk price data from Boston and Hartford, and then tests whether there have been any significant changes in the levels of farm-to-retail price markups that could have affected the net price paid by WIC programs for fluid milk.

## Data and Method

An autoregressive and moving average (ARMA) model is constructed to depict the relationship between retail fluid milk prices, their past values, past prediction errors, and other factors such as Class I milk price. Results from this model can provide evidence to answer the questions posed earlier. This section first describes the data, then presents the econometric specification of the ARMA model, and finally identifies the hypotheses to be tested.

### Data

Three monthly price series were used in this study: (1) retail fluid milk prices for Boston and Hartford, (2) the Class I milk prices for Zone 21, and (3) the Compact price (i.e., the Class I milk price plus the Compact over-order premium). Since price regulation under the Compact began in July 1997, the Compact over-order premium set by the Compact Commission is available only since July 1997. While data from January 1990 to June 1997 were used to estimate the models, data from July 1997 to June 1998 were used to forecast the price and markups with no Compact in effect. This study is limited to Boston and Hartford due to data availability. Massachusetts and Connecticut account for more than 60% of New England WIC participants.

### An ARMA ( $p, q$ ) Model of Milk Price

This section presents an autoregressive-moving average (ARMA) model that will be used to test the impacts of the Compact on the WIC program. In an

ARMA model, the dependent variable, retail fluid milk price, is a function of both its past values, past errors and current and past values of other variables. The model can be used to examine the relationships and to forecast future values of the dependent variable (Pindyck and Rubinfeld 1991; Greene 1993). In order to investigate the changes in the net fluid milk price paid by WIC programs in Boston and Hartford, we consider the Class I milk price for Zone 21 ( $P^I$ ), the Compact milk price ( $P^C$ ), retail fluid milk prices in Boston ( $P^B$ ) and Hartford ( $P^H$ ), and the net price paid by the WIC program ( $P^W$ ). The relationships of these variables can be expressed as follows:

$$(1) \quad P^C = P^I + R,$$

$$(2) \quad P^j = P^C + m^j$$

$$(3) \quad P^{Wj} = P^j - R,$$

where  $j = B$  for Boston and  $j = H$  for Hartford,  $R$  is the Compact over-order premium set by the Compact Commission, which did not exist during the pre-Compact period, and  $m^j$  is the markup at market  $j$ , which is defined as the difference between the retail price and Class I price in the pre-Compact period and the difference between retail price and Compact price in the post-Compact period.  $R$  is also the reimbursement by the Compact Commission to the WIC program (i.e., the Compact over-order premium). Note that the net price paid by WIC programs in the pre-Compact period was equal to the retail price (i.e.,  $P^{Wj} = P^j$ ). Then, the retail price at market  $j$  is

$$(4) \quad P^j = P^C + m^j = (P^I + R) + m^j$$

and the net milk price paid by WIC program at market  $j$  is

$$(5) \quad P^{Wj} = P^j - R = (P^I + R) + m^j - R = P^I + m^j.$$

Equation (5) indicates that if there is no significant change in the markup behavior between the pre-Compact and post-Compact periods, the net price paid by WIC programs for fluid milk should not show any significant change. In other words, the Compact did not affect the net price paid by WIC programs if the increase in retail fluid milk price in the post-Compact period was equal to the Compact over-order premium. Thus our first task is to forecast retail fluid milk prices in Boston and Hartford that would exist assuming there was no Compact in effect for the post-Compact period. For this purpose, we estimate an autoregressive-moving average (ARMA) model of retail fluid milk price using data from the pre-Compact period and then use the estimated model to forecast retail fluid milk prices

**Table 2. Estimation Results of the ARMA Model of Retail Milk Prices for Boston and Hartford (January 1990 to June 1997)**

| Process                         | Boston    |                | Hartford  |                |
|---------------------------------|-----------|----------------|-----------|----------------|
|                                 | Parameter | Standard Error | Parameter | Standard Error |
| Intercept                       | 1.829**   | 0.149          | 2.118**   | 0.087          |
| Autoregressive Parameters       |           |                |           |                |
| $z_{t-1}$                       | 0.937**   | 0.055          | 0.901**   | 0.065          |
| $z_{t-12}$                      | -0.051    | 0.059          | -0.112**  | 0.060          |
| Moving Average Parameters       |           |                |           |                |
| $\varepsilon_{t-1}$             | 0.307**   | 0.134          | 0.395**   | 0.145          |
| $\varepsilon_{t-12}$            | 0.095     | 0.148          | -0.066    | 0.154          |
| Class I milk price <sup>a</sup> |           |                |           |                |
| $P_t^I$                         | 0.261**   | 0.098          | 0.077     | 0.058          |
| $P_{t-1}^I$                     | 0.043     | 0.100          | 0.083     | 0.058          |
| $P_{t-12}^I$                    | 0.174**   | 0.084          | 0.090**   | 0.047          |
| Estimate of Variance            | 0.0017    |                | 0.0004    |                |
| AIC                             | -311.23   |                | -371.8641 |                |

$P_t^I$ ,  $P_{t-1}^I$ ,  $P_{t-12}^I$  are the Class I milk prices in the current month, in the last month, and in the same month of the previous year.

\*\* $p < .05$ .

for the post-Compact period. The ARMA model of a time-series process,  $y(t)$ , can be represented by

$$(6) \quad \phi(B)y_t = X_t\beta + \theta(B)\varepsilon_t$$

where  $\phi(B) = 1 - \phi_1B - \phi_2B^2 - \dots - \phi_pB^p$ ,  $\theta(B) = 1 - \theta_1B - \theta_2B^2 - \dots - \theta_qB^q$ ,  $\phi$ s and  $\theta$ s are autoregressive and moving-average parameters to be estimated,  $X_t$  is a vector of exogenous variables, with or without lags, that affect the process  $y_t$ , and  $\beta$  is the corresponding vector of parameters to be estimated. Note that  $B$  is the backward shift operator, i.e.,  $B^k z_t = z_{t-k}$ .

The procedures to investigate the impact of the Compact on the net fluid milk price paid by WIC programs are as follows: (a) Estimate the ARMA model using data from the pre-Compact period, (b) forecast the net retail fluid milk prices for the post-Compact period,  $P_t^{wj}$ , based on the estimated ARMA model, (c) calculate the net fluid milk price paid by WIC programs over the post-Compact period,  $P_t^{wj} = P_t^j - R$ , and (d) test the hypothesis that the net price paid by WIC programs in the post-Compact period is equal to the predicted price without the Compact by comparing  $P_t^{wj}$  and  $P_t^{j*}$  (i.e., the null hypothesis is  $P_t^{wj} = P_t^{j*}$  and the alternative is  $P_t^{wj} \neq P_t^{j*}$ ).

If the net price paid by WIC programs in the post-Compact period is different from the predicted milk price with no Compact in effect (i.e., the null hypothesis is rejected), a major factor that is likely to be responsible is a change in the markups of wholesalers and retailers. For this study, if the null hypothesis is rejected, a similar ARMA model will be used to predict the markups in the

post-Compact period under the assumption of no Compact in effect and then test if the markups have changed significantly in the post-Compact period as compared to historical relationships.

### Has the Net Price Paid by WIC Programs Increased Significantly?

Since a model specification test suggests that there is no integration of the process for both Boston and Hartford, an ARMA model rather than an autoregressive integrated moving average (ARIMA) model is used for the analysis of retail milk prices in Boston and Hartford. The orders,  $p$  and  $q$ , of the autoregressive-moving average (ARMA) process are determined according to the Akaike Information Criteria (AIC) (Greene 1993). As shown in table 2, both the autoregressive and moving-average orders of the process include 1-month and 12-month lags, which implies that the retail fluid milk price is affected by its levels as well as the unexplained disturbances in the last month and in the same month last year. We also include the Class I milk price as an additional explanatory variable. It is specified in the model with its values in the current month, the previous month, and the same month in the previous year. The estimation results suggest that the estimated models fit the data very well.

Estimates of the first-order autoregressive parameter are 0.937 for Boston and 0.901 for Hartford, and both are significant at the 0.95 level. This implies that the retail fluid milk price in any particular month is significantly and positively affected by its level in the previous month. The es-

**Table 3. Impacts on the Net Price Paid by the WIC Program in Boston and Hartford<sup>a</sup>**

| Year | Month     | OOP <sup>b</sup> | Boston       |                                    |                                      |                         | Hartford     |                                    |                                      |                         |
|------|-----------|------------------|--------------|------------------------------------|--------------------------------------|-------------------------|--------------|------------------------------------|--------------------------------------|-------------------------|
|      |           |                  | Retail Price | Net Price Paid by WIC <sup>c</sup> | Forecasted Retail Price <sup>d</sup> | Difference <sup>e</sup> | Retail Price | Net Price Paid by WIC <sup>c</sup> | Forecasted Retail Price <sup>d</sup> | Difference <sup>e</sup> |
| 1997 | January   |                  | 2.42         | 2.42                               | 2.37                                 |                         | 2.51         | 2.51                               | 2.48                                 |                         |
|      | February  |                  | 2.45         | 2.45                               | 2.39                                 |                         | 2.49         | 2.49                               | 2.48                                 |                         |
|      | March     |                  | 2.45         | 2.45                               | 2.44                                 |                         | 2.49         | 2.49                               | 2.48                                 |                         |
|      | April     |                  | 2.45         | 2.45                               | 2.46                                 |                         | 2.49         | 2.49                               | 2.49                                 |                         |
|      | May       |                  | 2.45         | 2.45                               | 2.46                                 |                         | 2.49         | 2.49                               | 2.49                                 |                         |
|      | June      |                  | 2.44         | 2.44                               | 2.44                                 |                         | 2.49         | 2.49                               | 2.49                                 |                         |
|      | July      | 0.259            | 2.64         | 2.38                               | 2.43                                 | +0.05                   | 2.68         | 2.42                               | 2.48                                 | +0.06*                  |
|      | August    | 0.255            | 2.63         | 2.37                               | 2.44                                 | +0.07                   | 2.68         | 2.42                               | 2.47                                 | +0.05                   |
|      | September | 0.245            | 2.63         | 2.39                               | 2.46                                 | +0.07                   | 2.68         | 2.44                               | 2.47                                 | +0.03                   |
|      | October   | 0.141            | 2.62         | 2.48                               | 2.50                                 | +0.02                   | 2.68         | 2.54                               | 2.48                                 | -0.06*                  |
|      | November  | 0.078            | 2.63         | 2.55                               | 2.53                                 | +0.02                   | 2.68         | 2.60                               | 2.49                                 | -0.11*                  |
|      | December  | 0.273            | 2.63         | 2.56                               | 2.52                                 | -0.04                   | 2.68         | 2.61                               | 2.48                                 | -0.13*                  |
| 1998 | January   | 0.064            | 2.60         | 2.54                               | 2.48                                 | -0.06                   | 2.68         | 2.62                               | 2.46                                 | -0.16*                  |
|      | February  | 0.035            | 2.59         | 2.55                               | 2.47                                 | -0.08                   | 2.68         | 2.64                               | 2.45                                 | -0.19*                  |
|      | March     | 0.039            | 2.60         | 2.56                               | 2.48                                 | -0.08                   | 2.68         | 2.64                               | 2.45                                 | -0.19*                  |
|      | April     | 0.033            | 2.60         | 2.57                               | 2.49                                 | -0.08                   | 2.68         | 2.65                               | 2.45                                 | -0.20*                  |
|      | May       | 0.077            | 2.60         | 2.52                               | 2.48                                 | -0.04                   | 2.68         | 2.60                               | 2.44                                 | -0.16*                  |
|      | June      | 0.146            | 2.54         | 2.39                               | 2.44                                 | +0.05                   | 2.61         | 2.46                               | 2.42                                 | -0.04                   |

<sup>a</sup>Based on estimates of the ARMA model over January 1990 to June 1997.

<sup>b</sup>The Compact over-order premium per gallon, which is calculated by dividing the over-order premium per cwt by 11.6.

<sup>c</sup>Equals the retail price minus the OOP.

<sup>d</sup>Predicted values for the pre-Compact period.

<sup>e</sup>The difference between forecasted retail price and the net price paid by WIC. Positive numbers indicate that the predicted prices without the Compact are greater than the actual net prices paid by the WIC programs and the negative numbers indicate that the predicted prices without the Compact are less than the actual net price paid by the WIC programs.

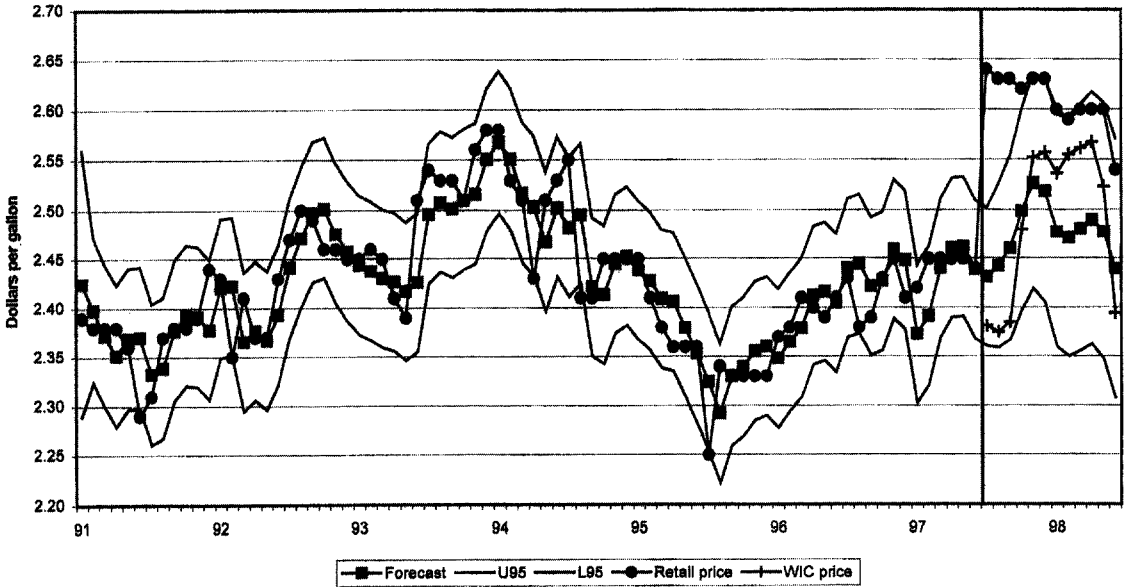
\*Significant at the 0.95 level.

timate of the 12<sup>th</sup>-order autoregressive parameter is negative for both cities and significant only for Hartford. It means that the price level in the same month of the previous year plays a role of dampening the large effect of the one-month previous level on the current price level. The estimated parameter for the Class I milk price at the current month is positive for both cities but significant for Boston only. The parameter of Class I milk price in the previous month is not significant and the parameter of Class I price in the same month in the previous year is significant for both cities.

Based on the estimation results in table 2, we obtain forecasts of retail fluid milk prices ( $P^j_*$ ) over the post-Compact period under the assumption of no Compact was in effect and that there was no exogenous shock in retail prices. The results of forecasts are presented in table 3 for Boston and Hartford. The actual net price paid by WIC is the retail price less the Compact over-order premium (OOP). The difference between the forecasted retail price and the actual net price paid by the WIC programs indicates how the actual net price paid by WIC programs differed from what would have been expected during July 1997 to June 1998 with-

out the Compact. If the difference is positive and statistically significant, it implies that the net price paid by WIC programs is significantly lower than what would be expected based on historical relationships between the retail fluid milk price and the Class I milk price. However, if the difference is negative and statistically significant, it implies that the net price paid by WIC programs is significantly higher than what would be expected based on the historical relationships. A difference that is not statistically significant implies that we can not determine the difference although it may exist. Any negative and statistically significant differences are of greater interest because higher net prices to WIC programs may adversely affect the cost of WIC programs and milk availability to program participants.

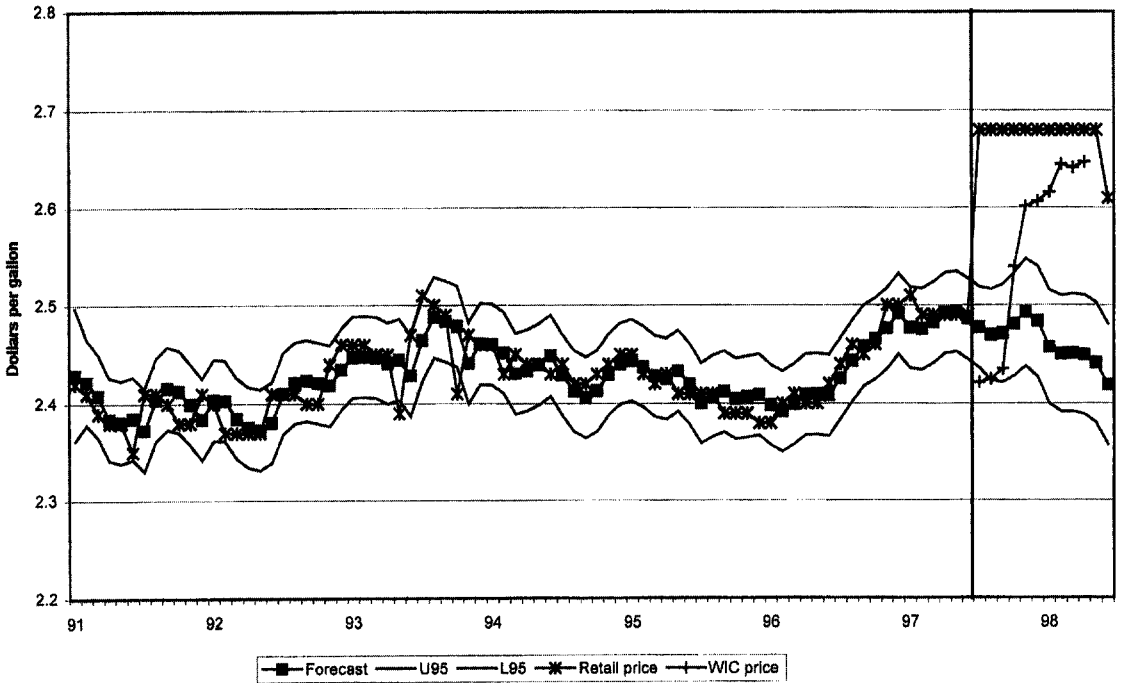
For Boston, the actual net price for fluid milk paid by the WIC program is not statistically significantly different from the price predicted by the model in the absence of the Compact (figure 2). This suggests that the net price paid by the WIC program in Boston, within the limits of statistical uncertainty, was not significantly affected by the price regulation under the Compact. For Hartford,



**Figure 2.** Actual & Predicted Retail Milk Price and the Net Price Paid by WIC Program in Boston

the net price paid by the WIC program was significantly lower than the predicted value in the first month of the Compact but significantly higher than the predicted value during most of the remaining months except June 1998 (figure 3). This pro-

vides evidence that the net price for fluid milk paid by the WIC program in Hartford during much of the first year of Compact was higher than would have been expected based on historical relationships.



**Figure 3.** Actual & Predicted Retail Milk Price and the Net Price Paid by the WIC Program in Hartford

**Table 4. Estimation Results of the ARMA Model of Markups in Boston and Hartford (January 1990 to June 1997)<sup>b</sup>**

| Process ( $z_t$ )          | Boston Model |                | Hartford  |                |
|----------------------------|--------------|----------------|-----------|----------------|
|                            | Parameter    | Standard Error | Parameter | Standard Error |
| Intercept                  | 1.656**      | 0.161          | 2.035**   | 0.093          |
| Autoregressive Parameters  |              |                |           |                |
| $z_{t-1}$                  | 0.945**      | 0.046          | 0.827**   | 0.093          |
| Moving Average Parameters  |              |                |           |                |
| $\varepsilon_{t-1}$        | 0.338**      | 0.127          | 0.249     | 0.249          |
| Class I Price <sup>a</sup> |              |                |           |                |
| $P_t^I$                    | -0.630**     | 0.101          | -0.861**  | 0.062          |
| $P_{t-1}^I$                | 0.078        | 0.093          | -0.081    | 0.059          |
| $P_{t-12}^I$               | 0.153*       | 0.076          | -0.092    | 0.049          |
| $D_{97}$                   | 0.095**      | 0.038          | 0.051**   | 0.019          |
| Estimate of Variance       |              | 0.0012         |           | 0.0004         |
| AIC                        |              | -296.25        |           | -377.02        |

<sup>a</sup> $P_t^I$ ,  $P_{t-1}^I$ ,  $P_{t-12}^I$  are the Class I milk prices in the current month, in the last month, and in the same month of the previous year.  $D_{97}$  is a dummy variable, which equals one for all the months since January 1997 and zero for other periods.

\* $P < .10$ , \*\* $P < .05$ .

### Have the Markups Changed Significantly?

As discussed in the previous section, changes in retail fluid milk prices in the post-Compact period are likely due to at least two major factors: changes in milk price paid by milk processors due to the Compact over-order premium and changes in markups. Because the net price paid by WIC in Hartford over the post-Compact period was significantly higher than the forecasted price with no Compact in effect, we now examine whether there has been any significant change in the markups of wholesalers and processors in Hartford. The analysis of markups helps to explain the underlying reasons for changes in the net price paid by WIC. For the purpose of comparison and examining the methodology, a similar analysis is also conducted for Boston.

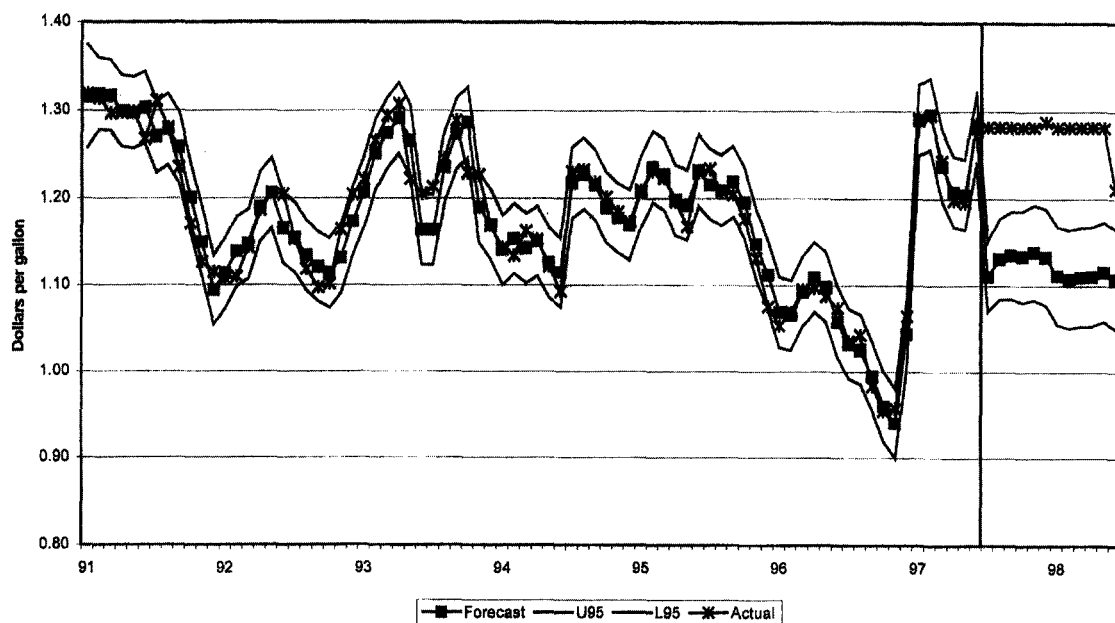
Similar to the ARMA analysis presented in the previous section, we examine the changes in markups using an ARMA (1,1) model. Table 4 presents the estimated model for Boston and Hartford. For both cities, estimates of autoregressive parameters are significant. The estimates of the moving average parameter are significant only for Boston. To explain the markup process, we included some additional explanatory variables: levels of the Class I price in the current month, previous month, and the same month of the previous year, and a dummy variable ( $D_{97}$ ) that equal 1 for months since January 1997 and 0 otherwise. The dummy variable is to capture the jump in markups in early 1997. Estimates of the dummy variable are significant and positive for both cities as expected. The current level of Class I price has a significant and negative

effect on the markups. This is consistent with the observations that the mark-up of wholesalers and retailers is generally negatively related to Class I milk prices.

One way to examine whether there has been a change in markups is to compare the observed markups with the markups that would have been expected given a change in processors' fluid milk cost. To do this, we compare the observed markups with the markup that our model predicts given the increased cost of fluid milk to processors under Compact price regulation. Based on historical relationships, the model predicts that an increase in the cost of fluid milk to processors will result in a decrease in the markups, at least in the short run. Thus, based on historical price relationships, the increase in milk prices paid by processors due to the Compact over-order premium is predicted to result in a decrease in markups.

While a decrease in predicted markups in Hartford when price regulation under the Compact became effective in July 1997 is shown in figure 4, the actual markups remained about the same level as in previous months, despite the increase in the cost of milk to processors. The difference between the predicted markups and the observed markups was statistically significant for Hartford for the whole period (July 1997 to June 1998). This provides evidence that retailers and wholesalers in Hartford changed their markup behavior at times during the Compact took effect. Retailers and wholesalers maintained their markups for fluid milk by raising retail milk prices when price regulation under the Compact took effect, rather than let margins fall as they appear to have done during





**Figure 4. Actual Mark-up and the Mark-up Predicted with the Compact Price for Hartford**

1990 to mid-1997. The results for Boston, not presented in this paper, indicate that the difference between the predicted markups and the observed markups was statistically significant for only the first two months of the Compact.

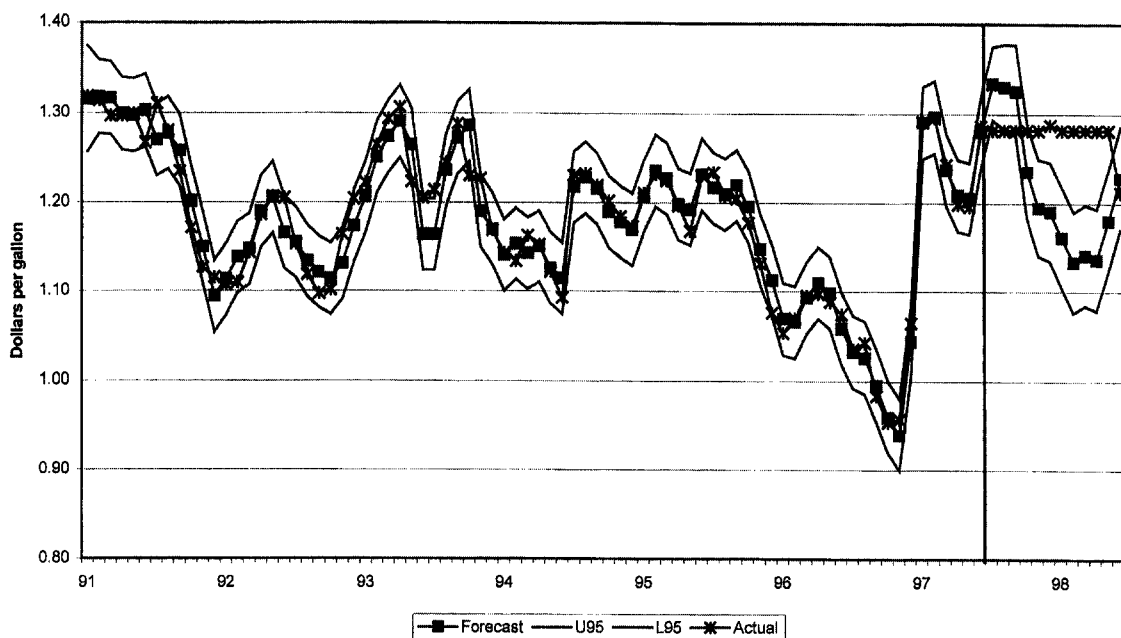
Given the evidence of changes in markup behavior by wholesalers and retailers, we wish to examine whether the actual markups differed from the markups that would have been expected in the absence of Compact price regulation. The difference between these two quantities provides additional evidence about the changes in the net price paid by WIC, as indicated by equation (5). To make this comparison, we calculate the difference between the actual markups and the markups predicted with our model using the Compact price as the cost of fluid milk to processors. Consistent with the results for the analysis of the net price paid, there is no statistically significant difference between the actual and predicted values of the markup in the Boston market. Thus, there is little evidence from our analysis of markups that the net price paid by the WIC program in Boston increased after the onset of Compact price regulation.

In Hartford, however, the story is different. The actual markups in Hartford were statistically significantly higher than the predicted values (figure 4). This provides evidence that the net price paid by the WIC program was higher than it would have been in the absence of the Compact. Because our markup models were estimated using Class I price,

one possible argument may be that the markups should be predicted using the Class I price rather than the Compact price. To address this concern, we calculated the predicted markups using the Class I price for both Boston and Hartford. As expected, the predicted markups using the Class I price are higher than that using the Compact price due to the negative relationship. While there is no change in the conclusion for Boston, the results for Hartford indicate that, during the first three months of the Compact price regulation, the predicted markups were statistically significantly higher than the actual markups (figure 5). From November 1997 to May 1998, however, the actual markups in Hartford were statistically significantly higher than the predicted values. The analyses summarized in figures 3 to 5 together indicate that the higher net price paid for fluid milk by the WIC program in Hartford resulted from higher than predicted markups in the Hartford market.

## Conclusions

Milk price regulation under the Compact has been in effect since July 1997. Although its main objective is to improve the sustainability of dairy farms, it has been associated with increases in the retail fluid milk price, particularly during the first month of price regulation. This study examines two possible causes of the increases in retail fluid milk prices in Boston and Hartford and their potential



**Figure 5. Actual Mark-up and the Mark-up Predicted with the Class I Price for Hartford**

effects on the WIC programs. In genera, the total number of WIC participants in the Compact states decreased slightly in the first three months of the Compact but increased over the October 1997 to February 1998 period. This suggests that the number of participants in WIC programs has not been significantly affected by the Compact. However, we do not have data to examine whether the composition of food packages and the nutrient sources have been changed.

Our statistical models suggest that the retail fluid milk price and markup behavior changed significantly in the first two months of the Compact in Boston and for most of the months in Hartford. For Boston, the analyses of retail prices and markups indicate that there was no statistically significant difference between the actual net price paid by WIC and the net price predicted in the absence of the Compact. This provides evidence that reimbursement of the Compact over-order premium by the Compact Commission is helping to avoid an increase in the cost of fluid milk to Boston WIC programs. However, for Hartford, both the retail price and markup models indicate that the net prices paid by the WIC program were greater than the predicted values from November 1997 to May 1998. Thus, despite reimbursement of the Compact over-order premium, it appears that the WIC program in the Hartford area paid higher net prices for

fluid milk than it would have in the absence of the Compact.

These higher net prices resulted primarily from a change in markup behavior by wholesalers and retailers in the Hartford market after Compact implementation. A possible explanation for the difference between Boston and Hartford is the differences in market concentration and competition—the Boston market may be more competitive or more efficient and therefore both the retail fluid milk price and the markups are relatively lower than that in Hartford. Future studies can benefit more explicit treatment of these factors.

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