

The Effect of the Northeast Dairy Compact on Producers and Consumers, with Implications of Compact Contagion

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We model and measure the effects of the Northeast Dairy Compact on prices, quantities, and producer and consumer welfare, underscoring the distribution of these effects across regions and among producer and buyers. Using 1999 as a base year, simulations show that the Compact raises the farm price of milk in the Northeast by \$0.45/cwt., lowers the farm price of milk in the rest of the country by \$0.02/cwt., and transfers income from producers outside the Compact region and buyers in the Compact region to producers in the Compact region. We find that non-Compact producer losses exceed Compact producer gains. Similar results are found for a scenario of Compact contagion—extension of the Compact to include additional states. In both cases, the Compact changes the distribution of the costs and benefits of price discrimination as practiced by milk marketing orders. We conclude that the regional distribution of the Compact's welfare effects raises again the question of the organization of a government-sponsored milk marketing plan such as the FMMO system.

Key words: dairy compact, dairy policy, government-sponsored cartels, marketing orders, milk policy, price discrimination, revenue pooling

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Federal and state regulation has played an important role in the United States dairy industry, dating back to Depression-era programs. Program categories include: (i) federal and state marketing orders that regulate raw milk prices; (ii) government purchases of manufactured dairy products to support the farm price of milk; (iii) import barriers for manufactured dairy products; and (since 1985) (iv) export subsidies for manufactured dairy products (Benedict; Manchester and Blaney; Bailey (1997); Manchester; Erba and Novakovic; Sumner and Cox). In addition to these price and quantity regulations, federal and state governments also have played an active role in setting food safety and sanitary regulations for milk and dairy products. All of these policy instruments are still in effect today, although with modifications.

The Northeast Interstate Dairy Compact (hereafter Northeast Compact or Compact) has added a new element to milk pricing in the United States. The Compact has potentially important implications for prices, production and policy in the U.S., including the pricing of raw milk through the Federal Milk Marketing Order (FMMO) system. The Northeast Compact raises the price paid to New England producers, thus increasing production of producers in the Compact and lowering the milk price received by producers outside the Compact. In effect, the Compact allows New England producers to increase the benefits they receive from the system to the detriment of local consumers and of producers in other regions.

Several authors have examined aspects of the Northeast Compact. Bailey (1999 and 2000) and U.S. OMB use models of price discrimination (Parish, Ippolito and Masson) to reason that the Compact would raise revenues for Northeast producers and find that this reasoning is consistent with the data. Nicholson, Resosudarmo and

Wackernagel provide econometric evidence that the Compact encourages increased milk supply from the Northeast region. Wackernagel uses a farm simulation model to show that, by raising the farm price of milk and lowering price variability, the Compact improves the financial performance of a representative Vermont dairy farm.

This paper lays out in an explicit and consistent framework the quantitative market-level effects of the Northeast Compact on producers and consumers in New England¹. Further, we analyze the Compact's effects on producers and consumers in the rest of the United States. Unlike previous studies, we model milk supply and demand to which FMMO and Compact regulations are applied, and simulate counter-factual scenarios against which we measure the Compact's effect. This paper goes beyond the immediate effects of the current Compact to consider the potential welfare implications of what we call Compact contagion—the expansion of the Northeast Compact and the formation of new regional dairy compacts. We also consider the implications for FMMO stability.

As expected, and as our analysis shows, Northeast producers—who produce a relatively small portion of the country's milk—have a correspondingly small effect on national milk prices. Nonetheless, the Compact has been controversial because (i) its welfare effects are distributed unevenly among producers and consumers of different regions, and (ii) because it sets the precedent for other states to possibly join the Northeast Compact or establish new compacts. We analyze and discuss both of these points. We show that an expanded Compact (or more compacts) would have greater influence on milk markets throughout the country. Further, we argue that independent,

regional administration of classified prices by compacts puts pressure on the FMMO system, a central part of U.S. dairy regulation for more than sixty years.

A Brief Description of Milk Marketing Orders

Milk marketing orders use price discrimination to raise the average price received by Grade A producers, setting minimum prices that may be paid for Grade A (fluid eligible) milk according to how that milk is used. The minimum prices for milk used in cheese, and milk used in butter and dry milk are set by federal orders according to formulae that take into account the wholesale prices of these products. The minimum price for milk used in fluid products in each order is set as a fixed differential over the manufacturing-use minimum prices². These administratively determined fluid differentials are not uniform across orders, but generally increase with an order's distance from Wisconsin. Each marketing order pools milk revenues from all end-use classes and pays a uniform, market-wide average price to individual farmers delivering milk to that order (USDA-AMS (a), Blaney, et al.; Bailey (1997); Erba and Novakovic; Sumner and Cox). The average, or blend price in any order depends not only on the classified prices but also on the utilization rates of the various milk classes, which also vary from order to order. Thus, producer prices vary across orders.

Each federal order is analytically similar to a certain type of cartel, as typically considered by economists. Often, members of a cartel, for example OPEC, increase profits by colluding to limit supplies. Federal milk marketing orders do not limit total quantity of raw milk, but achieve added revenue through price discrimination. A Federal Milk Marketing Order raises the price of milk sold for fluid uses. By raising the fluid

milk price and pooling revenues from that market with revenues from sales for manufactured product uses (for which demand is more elastic), the marketing order reduces fluid sales and raises overall production.

The entire FMMO system also can be thought of as a type of “cartel”. By establishing the relationship among minimum prices across regions, the FMMO system creates a certain distribution of producer benefits among regions (Cox and Chavas). Further, by setting different minimum prices (and thus different relative producer benefits) in different regions, the FMMO system creates potential for arbitrage, but limits arbitrage activity with disincentives to ship milk between regions (Bailey (1997), Manchester). This system has endured with modifications for more than sixty years in part because coordinated administration and enforcement of the classified pricing system has reduced independent action by the regional marketing orders.

Basic economic reasoning and evidence from many industries indicate that response to higher prices by individual members makes many such arrangements difficult to sustain. The economics literature of oligopoly refers to analogous behavior of cartel members as “cheating” on a cartel (Stigler (1964); Stigler (1975)). Because marketing orders do not control supply, “cheating” in this context takes on a novel form that we discuss in a later section.

Most major milk markets are regulated by the federal system of marketing orders. In 1998 about two-thirds of the Grade A milk produced in the country was regulated by the FMMO system. Of those markets not covered by the federal system, most belong to a state order. Of the state marketing orders, California is the most important, producing about 18% of the country’s Grade A milk. California’s pricing mechanism differs from

that of the FMMO, but the differences are not crucial for our analysis here. The California milk-pricing system also can be described as a government-sponsored cartel³. Because it is administered independently of the FMMO, the California system does not bear the same implications for stability, as we discuss later.

A Brief Description of The Northeast Dairy Compact

With approval from Congress and the USDA, the state legislatures of New England granted the Compact Commission authority to regulate the minimum fluid-use (Class I) price within the region starting in July 1997⁴. The Compact's regulatory rules work in conjunction with the New England FMMO, based in Boston, Massachusetts. The Compact sets a fixed minimum price (as opposed to a fluid differential) for Class I milk sold to processors in New England. Thus the minimum price for Class I milk in those states effectively is the greater of the Compact minimum price or the FMMO announced minimum Class I price in the New England order⁵. The Compact does not set minimum prices for non-fluid end-use classes.

The Class I price that has been determined to be acceptable—by two-thirds vote of New England state delegations, and by producer referendum—is \$16.94 per hundredweight of milk (cwt). If the FMMO minimum Class I price in a particular month falls below \$16.94, processors are obligated to pay the difference to the Compact Commission on all Class I purchases. The Commission, in turn, distributes the revenue back to producers⁶. For detailed discussion of Compact history and rules, see Bailey (2000), Alexander et al., and the Northeast Dairy Compact Commission.

Qualitative Implications for Prices and Welfare

The Northeast Compact deviates from the pricing rules of the FMMO system for milk sold in New England by administering a minimum Class I milk price independent of the FMMO pricing system, thereby raising the average producer price for dairy farms delivering milk to New England processors. As a result, fluid milk consumers in those states face higher milk prices. Dairy farms not selling to New England processors lose, since the higher producer price in New England increases milk supply in those states and lowers the price of milk for producers throughout the rest of the country.

It is not surprising then that the Compact has faced controversy on two fronts. By raising Class I prices, the Compact transfers income from milk consumers to dairy farms within New England. The transfer can also be seen as a payment from relatively populous states, such as Massachusetts, to states with many dairy farms, such as Vermont. Indeed, it was such an interpretation that prompted the Massachusetts state legislature to consider seriously the possibility of withdrawing from the Compact (Tynan, Clancy).

The Compact is also controversial because of the effect such an institution can have on milk markets outside of the Compact region. As our results show quantitatively, the Compact raises the producer price in New England, which brings forth increased milk production from those states. Under classified pricing, additional production is allocated to the lower-priced manufacturing milk market, resulting in lower minimum class prices and blend prices for producers throughout the country. In the context of the FMMO system as a government-sponsored “cartel”, the Compact legally evades the FMMO rules. Indeed, the Compact acts as a type of cartel within the larger FMMO system

(Pindyck and Rubinfeld, p.456). But the FMMO system is not the typical, quantity-restricting cartel, and evasion or cartel cheating here takes a novel form. The Compact raises prices in its own region and, thus, increases production without regard for those producers outside the Compact who receive a lower milk price as a result of the increased production.

Because New England produces a relatively small portion of the country's milk, the Northeast Compact has a relatively small effect on the price of manufacturing milk. However, dairy farms in other regions have a similar incentive as New England producers to raise Class I prices through compacts. If other states join the Northeast Compact or form similar regional compacts, the costs imposed on fluid milk consumers and non-compact producers will rise. Further, the potential for local administration of independent, regional classified prices raises questions about the continued sustainability of a nationally coordinated milk marketing system.

In the next section, we model and measure the effects of the Northeast Compact on milk prices and quantities, and on various producer and consumer groups. In a later section, we use the model to illustrate the effect of an expanded dairy compact or additional regional compacts.

Modeling the Effects of the Compact

Ippolito and Masson developed a well-known model of FMMO regulation, building from Kessel's model of price discrimination (see also Parish, who precedes this literature but applies his model to the Australian case). As with many intervening articles (Blaney et al.; Kwoka; Dahlgran; Cox and Chavas; Sumner and Cox; and Sumner and

Wolf, among others), we use this general framework to model marketing order price regulation. We use the same model to analyze the Northeast Compact's modification of marketing order regulation, and we compare market equilibrium under the two regimes. We describe the model in this section. In the next section, we parameterize the model and simulate the effects of the Compact.

We assume for simplicity that the FMMO system distinguishes between only two end-use classes of Grade A milk⁷. Milk used in fluid products is designated Class f, while milk used in manufactured products is designated Class m. Figure 1 depicts the model of the New England Grade A milk market. Due to the cost of shipping fluid milk and FMMO regulations that restrict the movement of milk across regions, the demand for Class f milk facing New England, $D_f(P_f)$, is regional and relatively inelastic. On the other hand, since manufactured dairy products are traded across the United States, New England faces a national demand for milk in manufacturing⁸. Since New England produces only a small fraction of the country's manufacturing milk, the portion of the national demand for Class m milk facing New England, $D_m(P_m)$, is relatively elastic. The supply of Grade A milk in New England is labeled $Q^S(P)$ and represents supply from all Grade A producers who deliver milk to processors regulated by the New England FMMO (including those producers who ship milk into the region from outside of New England).

In the absence of the Compact, we assume all Grade A milk is sold at the minimum prices set by the New England FMMO. The marketing order sets a fixed fluid differential, d , so that the price paid for fluid milk is

$$(1) \quad P_f \equiv P_m + d .$$

We assume that the price paid for manufacturing milk, P_m , is determined in a competitive market⁹. Each producer selling milk in this region receives a market-wide average price¹⁰ determined by

$$(2a) \quad P_b(P_m; d) = \frac{D_f P_f + D_m P_m}{D_f + D_m}$$

$$(2b) \quad = P_m + \frac{D_f}{D_f + D_m} d.$$

The average, or blend price, represented by the curved line in Figure 1, asymptotically approaches the aggregate demand curve under the FMMO's fixed differential policy, $D_f(P_m+d)+D_m(P_m)$, as P_m falls and an increasing share of milk is sold as Class m.

Equilibrium in this market is determined by the intersection of the blend price curve and the supply curve. Given this quantity supplied, the price for manufacturing milk, labeled P_m^* , is read off the aggregate demand curve. The marketing order sets the fluid price at $P_f^*=P_m^*+d$, at which price fluid demand is $D_f(P_f^*)$. The quantity of milk sold to the manufacturing market is the difference between supply and fluid demand.

Unlike the FMMO, the Compact sets a fluid price directly (as opposed to setting a differential) such that the effective fluid price under the Compact is no lower, and often higher, than the price set by the marketing order. The Compact, if it is to have any effect, raises the minimum price of Class f milk and transfers the additional revenues to producers. Figure 2 represents the same supply curve and fluid demand curve (those for New England) as in Figure 1. The manufacturing demand curve, also the same as in Figure 1, is omitted for clarity. However, the aggregate demand curve and blend price curve (in bold) corresponding to the Compact's policy are slightly different. Subscript c denotes equilibrium prices and quantities under the Compact's policy. If the Compact

sets a minimum Class f price at P_c , the effective minimum fluid price for the region becomes $\max(P_c, P_f)$. The Compact sets the fluid price such that $P_c > P_f$, so the aggregate demand for milk becomes $D_f(P_c) + D_m(P_m)$, where the fluid milk price and quantity demanded are now fixed.

The blend price paid to producers under the Compact's pricing rule is

$$(3) \quad P_{bc}(P_m; P_c) = \frac{D_f P_c + D_m P_m}{D_f + D_m},$$

which asymptotically approaches the aggregate demand curve under the fixed Class f price policy as P_m falls and an increasing share of milk is sold as Class m. This is similar to the case under the FMMO pricing scheme, but, as we just noted, aggregate demand is slightly different under the two regimes.

The arrows in Figure 2 indicate the direction of the Compact's effects on the equilibrium prices and quantities in this market, relative to the FMMO equilibrium of Figure 1. By raising the minimum fluid class price, the Compact reduces Class f sales. The blend price line thus shifts upward under the Compact rules, intersecting the supply schedule at a higher price than the FMMO blend price. The higher blend price encourages an expansion in the milk supply along the supply schedule. With more milk supplied and less milk used in Class f, the supply of Class m milk from New England expands relative to the FMMO equilibrium, lowering the price for manufacturing milk.

By raising the blend price in the Compact region, the Compact raises the revenues of New England dairy farms (and of other farms that ship milk to Compact region handlers). Additional producer revenues come at the expense of fluid milk consumers, who must pay higher prices. The additional loss in fluid milk consumer surplus due to

the Compact can be seen in Figure 2 as the area to the left of the fluid demand curve, and between the Compact and FMMO minimum Class f prices.

The Compact's effects on producers and consumers in other regions work through the price of manufacturing milk. If New England produces and sells more milk on the manufacturing market, the prices of manufactured dairy products and the price for Class m milk throughout the country are driven lower¹¹. Class f prices in other marketing orders are also lower due to the Class m-plus-differential formula used to obtain Class f minimum prices. Milk supply in non-Compact regions contracts due to lower producer prices¹². On the other hand, consumers of manufactured dairy products, and consumers of fluid milk outside of the Compact enjoy lower prices.

From the model, it is clear that the Compact's effects on producers and consumers outside of the Compact region depends on Compact producers' ability to affect the prices in the manufacturing milk market. Were the Compact's share of the manufacturing market to grow—either through expansion of the Northeast Compact to include more states or through the formation of new regional dairy compacts—the effect on national milk prices would also grow (i.e. the demand curve for manufacturing milk facing the Compact region would be steeper).

In the following section, we parameterize the model and estimate the Compact's effect on prices, quantities, and producer and consumer welfare. In a later section, we explore the possibility of growth of the Compact to include a larger share of national milk production.

Measuring Policy Incidence

Like previous users of similar models (Ippolito and Masson, Blaney et al.; Kwoka; Dahlgran; Cox and Chavas; Sumner and Cox; and Sumner and Wolf), we assume locally linear supply and demand throughout the paper. Our results would be similar under a constant elasticity or other functional form specification. Our methodology is as follows:

1. Use public data collected under the Compact regime and elasticities from previous studies to parameterize the New England milk supply curve, the New England fluid milk demand curve, and the share of the national demand curve for manufacturing milk facing New England.
2. Using these supply and demand curves, simulate the equilibrium for the counter-factual scenario in which milk is priced according to the FMMO pricing rules in the absence of the Compact.
3. Compare prices, quantities, and welfare under the two regimes.
4. Consider the influence of parameter choices through sensitivity analysis (see appendix).

We parameterize the linear supply and demand model of Figure 2 using annual milk marketing data and supply and demand elasticities drawn from the agricultural economics literature. We use the most recent year with available data, 1999, as a base year for our simulations¹³. Our data consist of annual quantities and annual average prices of Class I milk and all milk published by the USDA and the Compact Commission. The data for the Compact region are listed in the first column of numbers in Table 1¹⁴. Data for the entire FMMO system are also included in Table 1 for comparison. The

annual average Compact fluid premium is \$1.20/cwt. That is, the Compact raises the Class I price in New England by \$1.20/cwt. relative to the announced FMMO Class I price. We impute the average manufacturing milk price from equation (2a), given the announced blend price and minimum Class I price, the quantity of Class I milk sold, and total milk marketed. We calculate the FMMO differential as the average FMMO Class I price less the imputed average manufacturing price. These data give us an observation on the fluid demand curve, one on the supply curve (which is also on the blend price curve), and another on the manufacturing demand curve.

A range of raw milk supply elasticities can be found in the agricultural economics literature. We consider an intermediate time horizon of 3 to 6 years to allow for adjustments in milk production through managed changes in herd size and productivity in response to an expected, permanent change in the relative price of milk. Chavas and Klemme estimated supply elasticity to range from 0.22 to 1.17 for this time frame. Cox and Chavas specify their model with supply elasticity of 0.37. Ippolito and Masson used estimates of 0.4 to 0.9 in their work. Helmberger and Chen estimated the “long run” milk supply elasticity to be 0.583, and Chen, Courtney and Schmitz estimated a supply elasticity of 2.53. We choose a supply elasticity of 1.0, which is well within the range of estimates used in prior studies.

The milk demand elasticities used to parameterize the model are also drawn from the agricultural economics literature. Estimates of the long run demand elasticity for fluid class milk range from -0.34 (Ippolito and Masson) to -0.076 (Helmberger and Chen). Estimates of the demand elasticity for manufacturing milk range from -0.350 (Helmberger and Chen; Dahlgran) to -0.2 (Ippolito and Masson). Heien and Wessells

estimated own-price elasticities of -0.63 for retail demand for milk, -0.52 for cheese and -0.73 for butter. Huang estimated own-price elasticities of -0.26 for retail demand for milk, -0.33 cheese and -0.17 butter. We assume that the elasticity of the national demand for manufacturing milk (at the farm level) is -0.2. We also assume a regional fluid demand elasticity of -0.2. Both of these are within the range of estimates used in prior studies. We refer the reader to Johnson et al. for detailed discussion on the theory and practice of demand analysis for milk and dairy products.

Our numerical results depend on our choice of supply and demand elasticity values. In the appendix, we examine the sensitivity of our results to our assumptions on supply and demand elasticities. We find that our results do not vary greatly over a reasonable range of parameter values.

Following Ippolito and Masson, we calculate the elasticity of demand for manufacturing milk facing New England producers as

$$(4) \quad \eta^{\text{NE}} = \frac{1}{s} \eta^{\text{US}} + \left(1 - \frac{1}{s}\right) \varepsilon^{\text{ROC}},$$

where η^i is the demand elasticity in i ($i = \text{New England, United States}$); ε^{ROC} is the milk supply elasticity from the entire country less New England; and s is New England's share of the country's manufacturing milk production. In 1999, the New England states supplied only 3% of the nation's manufacturing milk. Given a supply elasticity of 1.0 and a national demand elasticity of -0.2, the elasticity of demand for manufacturing milk facing the Northeast is -39. Manufacturing milk demand facing New England is very elastic because New England produces such a small portion of the nation's manufacturing milk. Although Figures 1 and 2 focus attention on the New England milk market, the effects of the Compact on the rest of the country are built into the model through our

specification of the demand for manufacturing milk. In our model, price changes along the manufacturing milk demand curve facing New England (depicted in Figures 1 and 2) represent changes in the national price for manufacturing milk.

Using the data (Table 1) to anchor our supply and demand curves, the elasticities we choose imply the following (locally) linear specifications of the supply and demand curves:

$$\text{New England milk supply: } Q^S(P) = 4.3390P;$$

$$\text{New England inverse fluid demand: } P_f(Q_f) = 108.60 - 3.0046Q_f;$$

$$\text{New England inverse manufacturing demand: } P_m(Q_m) = 13.5221 - 0.0092Q_m.$$

We simulate the equilibrium for the No-Compact scenario by apply the FMMO price discrimination policy (Figure 1) to the market defined by these supply and demand equations. The no-Compact equilibrium is found as the intersection of the supply curve and the blend price curve, given a fluid differential of \$3.72/cwt. (imputed from the data in Table 1).

Table 2 compares the simulated equilibrium prices, quantities and welfare measures under the No-Compact scenario to those observed under the Compact regime. The higher fluid class price paid under the Compact rules raises the producer blend price in New England by \$0.447/cwt., encouraging more production and raising producer revenues. New England producers gain \$29.4 million as a result of the Compact. The Compact raises the price of fluid milk in New England by \$1.180, resulting in a loss in New England fluid consumer surplus of \$35.8 million. With increased production and reduced fluid consumption, New England expands manufacturing class sales causing a \$0.022 or 0.2 percent fall in the price of that milk¹⁵.

The difference between the gain in producer surplus and the loss in New England fluid consumer surplus does not equal deadweight loss because the Compact affects producers and consumers outside of New England by lowering the price for manufacturing milk. Producers delivering to other marketing orders also receive a blend price as described previously in equation (2b). We can express the blend price in a single order, i , equivalently as

$$(5) \quad P_{bi}(P_m; d_i) = P_m + s_i(P_m; d_i)d_i,$$

where $s_i(P_m; d_i)$ is the fluid class utilization rate, or the share of total production in region i used in fluid products. Taking the partial derivative of this last equation with respect to P_m yields

$$(6) \quad \frac{\partial P_{bi}}{\partial P_m} = 1 + \frac{\partial s_i}{\partial P_m} d_i.$$

Because manufacturing milk demand is more elastic than fluid demand, the derivative of s_i with respect to P_m is positive; for a given fall in the price of manufacturing milk, manufacturing quantity demanded rises by a greater amount than does fluid quantity demanded, causing the fluid utilization rate to fall. Thus, a fall in P_m due to the Compact causes the blend price in other federal orders to fall by more than the change in P_m . But for small changes in the manufacturing milk price we can ignore the change in fluid utilization and approximate the effect on order i 's blend price as

$$(7) \quad \frac{\partial P_{bi}}{\partial P_m} \approx 1.$$

Thus, to a very close approximation, the fall in the manufacturing milk price due to the Compact translates into fall of the same magnitude in the blend price received by producers in other regions.

The effects of lower manufacturing milk prices on producers outside of the Compact region (who do not deliver milk New England) are presented in Table 3. To highlight the interests of producers in various regions, we show losses to producers in California, Wisconsin and Minnesota—three major milk-producing states¹⁶. The loss to all producers outside the Compact region is also shown in Table 3. We assume a supply elasticity of 1.0 in each state. From equation (7), the \$0.022 drop in the price of manufacturing milk causes a \$0.022 drop in blend prices throughout the country. As a result, non-Compact producers lose \$33.7 million in producer surplus.

The lower manufacturing milk price benefits consumers of that milk. Consumers of manufacturing milk, who accounted for 1,070 million cwt. of milk in 1999, gained about \$23.1 million in consumer surplus thanks to the lower manufacturing price due to the Compact. Consumers of fluid milk outside the Compact region also gain from a lower manufacturing milk price. Because of the fixed differential policy, the price of fluid milk falls by the same amount as the change in the price of manufacturing milk (\$0.022). Non-Compact producers sold about 527 million cwt. of milk to the fluid market. (USDA-AMS (a), USDA-AMS (b)). Thus, fluid milk consumers outside of New England gained about \$11.4 million in consumer surplus thanks to lower fluid milk prices due to the Compact.

The net effect of the Compact on producers and consumers throughout the United States is the sum of the welfare effects reported in Tables 2 and 3. Again, Compact producers gain \$29.4 million and non-Compact producers lose \$33.7 million, so, interestingly, producers as a nation-wide group lose \$4.2 million. Fluid consumers in the Compact region lose \$35.8 million, fluid consumers outside the Compact region gain

\$11.4 million, and manufacturing consumers gain \$23.1 million; consumers as a group lose \$1.3 million. The deadweight cost of the Compact is \$5.6 million.

Our results are consistent with those of previous studies. Bailey (1998) assumes a Compact premium of \$2 per cwt. and thus finds slightly larger effects on milk prices, although in the same direction as our results. Our results are qualitatively similar to those found by the Office of Management and Budget for an earlier period, and are consistent with those of Nicholson, et al., who provide empirical evidence that the growth in New England production is linked to the higher producer price due to the Compact. Moreover, our welfare analysis makes explicit the income transfers caused by the Compact. The Compact makes New England producers better off at the expense of New England fluid consumers and producers in the rest of the country. The Compact results transfers income from New England fluid milk consumers and producers in the rest of the country to New England producers and consumers in the rest of the country.

Compact Contagion

Compact contagion refers to the potential growth of the dairy compact movement. Currently, six additional states may be eligible to join the Northeast Compact, conditional on Congressional consent and the stipulation that a state be contiguous to the current Compact region at the time of their entry. The state of New York has already approved participation in the Compact, and awaits Congressional approval. New Jersey and Maryland likewise await Congressional approval, while legislation to join the Compact has been introduced in the Pennsylvania House and Senate. Compact growth may also come in the form of new compacts formed in other regions of the country. Ten southern

states have already approved the formation of a Southern Dairy Compact that could stretch from Kansas to Virginia, and from Texas to Florida. States in the West and Midwest have also shown some interest in forming similar agreements (Compact Commission).

If the Compact grows to include a larger share of the nation's milk production—and more specifically, the nation's milk sold for manufacturing uses—it will have an increased effect on the national manufacturing milk price. In our model, equation (4) captures this relationship. As the Compact's share of the country's manufacturing milk market grows, manufacturing milk demand facing the Compact becomes less elastic, thus increasing the price effect of a given expansion in Compact manufacturing milk sales on the national market.

To illustrate, we now simulate the effects of adding New York and New Jersey to the Northeast Compact. The methodology is similar to steps (1) through (4) in the previous section, only here we specify the supply and demand curves of the New York-New Jersey (NY-NJ) federal marketing order, then simulate the effects of adding NY-NJ to the Compact. We then consider the price, quantity, and welfare effects of this policy relative to the (observed) scenario in which only New England is included in the Compact.

The 1999 data for the NY-NJ federal marketing order are listed in the “No Contagion” column of Table 4. These data reflect the pricing rules of the NY-NJ marketing order, as well as the effects of the original Northeast Compact analyzed in the previous section. The NY-NJ order regulated the sale of 116.61 million cwt. of raw milk, of which 69.92 million cwt. were used in manufacturing. NY-NJ accounts for about six

percent of the country's manufacturing milk, almost twice New England's share of manufacturing milk.

We assume the Compact raises the monthly minimum Class I price in NY-NJ to \$16.40, the Compact's minimum Class I price in New England. The minimum Class I price announced by the NY-NJ federal order was less than \$16.40 during six months in 1999, such that the Compact minimum would have raised the annual average Class I price in the region from \$16.82 to \$17.78. We assume a fluid demand elasticity of -0.2, national manufacturing demand elasticity of -0.2, and supply elasticity of 1.0, the same parameter values we assumed for the analysis of New England. By equation (4), the manufacturing demand elasticity facing NY-NJ is -19. The resulting linear approximations to the NY-NJ supply and demand curves are:

$$\text{NY-NJ milk supply: } Q^S(P) = 7.9327P;$$

$$\text{NY-NJ inverse fluid demand: } P_f(Q_f) = 100.92 - 1.8012Q_f;$$

$$\text{NY-NJ inverse manufacturing demand: } P_m(Q_m) = 13.9835 - 0.0100Q_m.$$

The prices and quantities that result from raising the fluid class price to \$17.78 are reported in Table 4 in the column labeled "Contagion". Table 4 compares the effects of adding NY-NJ to the Compact relative to the prices, quantities and welfare resulting from the New England-only Compact regime¹⁷. Expansion of the Compact to include NY-NJ raises the price of fluid milk in that region, resulting in a reduction in fluid consumption and a welfare loss of \$44.6 million to fluid milk consumers in NY-NJ. The expanded Compact raises the NY-NJ blend price by \$0.310/cwt. and NY-NJ producers gain \$36.5 million in producer surplus. The pattern of welfare costs and benefits within NY-NJ is similar to that found for the New England states in Table 2. However, because NY-NJ

accounts for almost twice as much production and fluid consumption as New England, the magnitude of the welfare effects is larger in NY-NJ even though the expanded Compact has a smaller effect on Class I and blend prices in NY-NJ than the original Compact has in New England.

The size of the NY-NJ region also translates into larger effects on the rest of the country through a larger effect on the price of manufacturing milk. NY-NJ producers sell an additional 3 million cwt. of manufacturing milk due to expansion of the Compact. This additional manufacturing milk lowers the national manufacturing milk price by \$0.029/cwt., resulting in a fall in class and blend prices in other regions by approximately the same amount. Table 5 presents the effects on the rest of the country of adding NY-NJ to the Compact relative to the New England only regime. Producers in California, who lose \$6.6 million due to the original Compact (Table 3), lose an additional \$9 million when the Compact includes NY-NJ. Similar results hold for producers in Wisconsin and Minnesota. Producers in New England also lose due to the addition of NY-NJ to the Compact, but the blend price in New England falls by less than the \$0.029 since the Compact fixes the fluid price in that region. The fall in the price of manufacturing milk only affects the 55 percent of New England's milk sold on the manufacturing market, resulting in a fall in New England's blend price of \$0.016. New England producers, who gain \$29.4 million by joining the Compact, lose \$1.4 million due to the addition of NY-NJ to the Compact. Producers outside of NY-NJ but including New England, lose \$43.6 million. Producers as a nation-wide group, who lose \$4.2 million due to the original Compact, lose an additional \$7.1 million due to "contagion" of the Compact to NY-NJ.

Fluid consumers outside the NY-NJ region gain an additional \$13.9 million in consumer surplus. The country's manufacturing milk consumers gain \$31.6 million in consumer surplus due to the expanded Compact. As a nation-wide group, consumers of all dairy products, who lose \$1.3 million due to the original Compact, gain almost \$1 million due to expansion of the Compact.

The deadweight cost of the original Compact is \$5.6 million. Compact "contagion" to NY-NJ generates an additional deadweight cost of \$6.2 million. Since the net effect on consumers is small, most of the net welfare loss comes from producers. Non-Compact producer losses exceed Compact producer gains, so that, interestingly, the Compact actually makes dairy farms worse off.

The income transfers induced by the Compact change the regional distribution of costs and benefits of price discrimination. Producers within the Compact benefit at the expense of local consumers and all other producers. Expansion of the Compact to additional states benefits producers in those states at the expense of local fluid consumers and all other producers, including those who are already in the Compact. In the next section, we discuss some implications of the Compact's distributional effects.

Federal Milk Marketing Order Stability

The dairy compact movement raises questions about the organization of the FMMO system. The expansion of the Northeast Compact and the creation of additional regional compacts are distinct possibilities (although not certain). How would regional administration of regional, independent classified prices affect the FMMO system?

A challenge for the typical, supply-limiting cartel is to enforce supply controls despite incentives created by the cartel for individual members to increase production (Stigler 1964). In the case of the dairy industry, the FMMO has served as enforcer of an implicit agreement among dairy farms across the country regarding how milk prices should be set in the various regions of the country. The terms of trade set and enforced by the FMMO system for each order determine the distribution of the benefits and costs of price discrimination among producers and consumers of the various regions (Cox and Chavas). The commerce clause of the U.S. Constitution puts clear limits on the authority of individual states or groups of states to operate regional compacts. The Compact, potential growth of the Compact, and potential new compacts threaten FMMO stability by permitting producers in individual regions to legally deviate from the implicit agreement to which non-Compact producers adhere, ignoring the consequences for producers outside their region, and upsetting the distribution of benefits resulting from FMMO policies.

Dairy farms in regions that determine and enforce their own regional prices may not suffer from the breakdown of the FMMO system. But federal enforcement and coordination of the milk marketing system are lost in such a scenario. Each individual regional compact would adjust classified prices strategically in order to raise local producer revenue at the expense of local consumers and producers in other regions. One possible result of this competition is that producers in regions with lower fluid utilization rates (i.e. those who benefit the least from the FMMO system) will withdraw from the federal system. This is exactly what the Upper Midwest producers and their political

representatives threatened in 1996 when the FAIR Act included authority for the Northeast Compact.

Conclusion

The Northeast Dairy Compact raises milk prices for those producers whose milk it regulates, creating for them additional producer surplus at the expense of fluid milk consumers in the Compact region and producers not delivering milk to New England. We found that the Compact raises New England producer prices by \$0.447/cwt., causing an expansion in the New England milk supply. Private consumers pay more for fluid milk in the Compact region, and thus reduce consumption. Additional manufacturing milk marketed by Compact producers lowers the average price for that milk by \$0.022/cwt., resulting in a loss for producers and a gain for consumers in all other regions.

In giving the New England states authority to form the Compact, Congress allowed them to act collectively to regulate the interstate commerce of milk. States in other regions are poised to join the Compact or form additional regional compacts. For the past sixty years, the Federal Milk Marketing Order system has determined the regional pattern of milk prices in much of the country, preserving those terms of trade by providing disincentives to ship milk across regions. By setting up a separate Compact, the New England states put pressure on the federal system by increasing the benefits its producers receive from price discrimination relative to producers in other regions in the federal system. By lowering the milk price for non-Compact producers, the Compact raises the incentive for producers in other regions to form similar pricing arrangements.

Congressional approval of the expansion of the Northeast Compact and of additional regional dairy compacts would increase the share of milk regulated by compacts. The clear losers are private consumers of fluid milk in any compact region, and all other producers, including those already in Compact states. Moreover, the compact movement raises again the question of the organization of a government-sponsored milk marketing plan. Independent, regional administration of regulated milk prices threatens the continued operation of the FMMO system.

Thus, the Northeast Compact has potential implications beyond its immediate effects on consumers and producers across the country. This paper brings these to light, and provides a methodology that can be extended to analyze milk markets under various possible policy scenarios involving marketing orders and compacts

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Appendix

We examined our simulation results for sensitivity to our assumptions on supply and demand elasticities. The table below shows the change in the national manufacturing price due to the Compact (without NY-NJ) under a range of supply, fluid demand and manufacturing demand elasticities that can be found in the literature. The elasticity of manufacturing demand facing New England (in parentheses) is calculated using equation (4), given that New England produces three percent of the country's manufacturing milk.

Sensitivity Analysis. Change in the manufacturing milk price due to the Compact (\$/cwt.)				
		New England Supply Elasticity		
		0.5	1	2
National Manufacturing Demand Elasticity	-0.1	-\$0.0228 (-19.5)	-\$0.0220 (-35.7)	-\$0.0200 (-68.0)
(New England Manufacturing Demand Elasticity in Parentheses)	-0.2	-\$0.0223 (-22.8)	-\$0.0215 (-39.0)	-\$0.0197 (-71.3)
	-0.3	-\$0.0218 (-26.2)	-\$0.0211 (-42.3)	-\$0.0194 (-74.7)

Figure 1. Milk Marketing Order Equilibrium

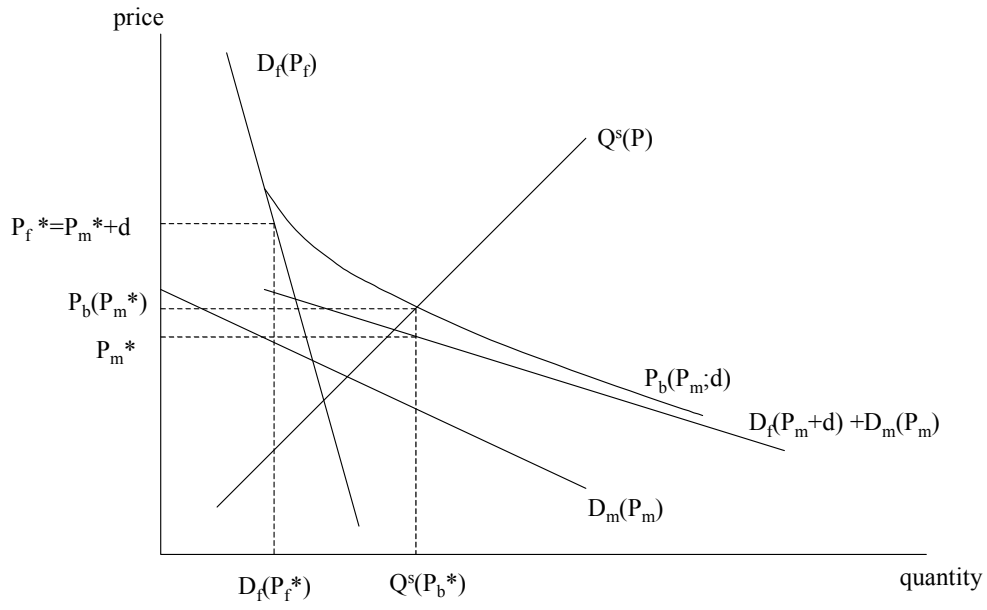


Figure 2. Compact Equilibrium

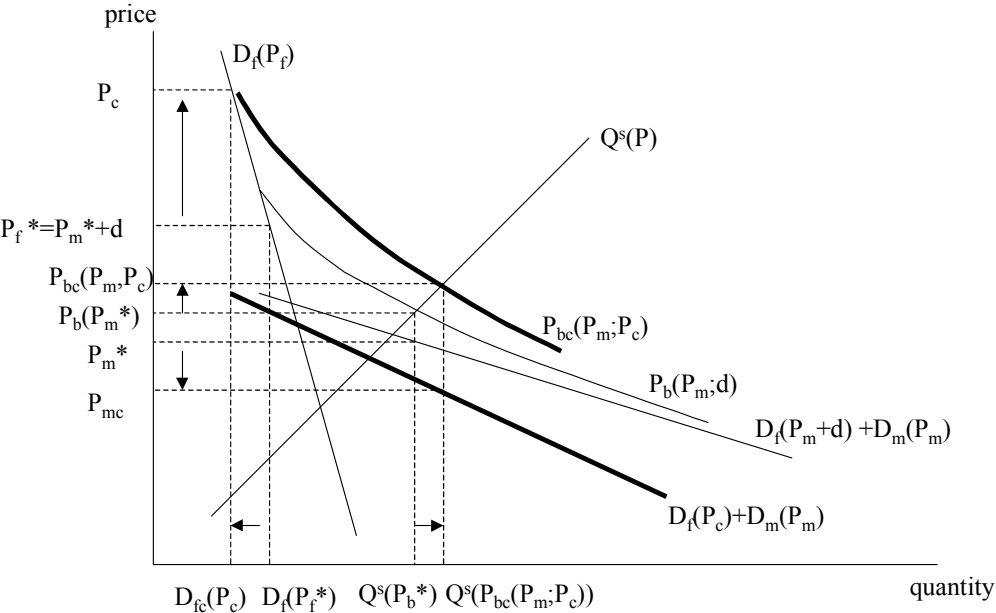


Table 1. Prices and Quantities Used in Base Year Simulations (1999)

	New England	All FMMO
		\$/cwt.
Avg Announce FMMO Class 1 price	16.90	16.24
Avg Compact Class 1 price	18.10	-
Avg Compact fluid premium	1.20	-
Avg blend price	15.40 ¹	14.09
Avg manufacturing price ² (imputed)	13.18	12.45
Avg FMMO fluid differential (imputed)	3.72	3.79
		Million cwt.
Total milk marketed	66.82	1,044.79
Total Class 1 milk	30.12	452.16
Total manufacturing milk	36.70	592.63

Source: USDA-NASS (a and b), Northeast Interstate Dairy Compact Commission

1. Includes Compact payment of \$0.49/cwt. ($= \$1.20(\text{Class I sales})/(\text{Total sales}) - \text{adjustments for WIC, etc.}$).
2. The average price of manufacturing milk in the Compact regions is higher than that of the FMMO due to a higher rate of utilization of milk in manufacturing classes with relatively high prices. The minimum price for each manufacturing class varies little, if at all, across regions, and the average price of manufacturing milk is highly positively correlated across regions due to the formulae used to calculate minimum class prices.

Table 2. Effects of the Northeast Dairy Compact on New England Producers and Consumers¹

	No Compact	Compact	Change	% change
Prices (\$/cwt.)				
Fluid class	16.920	18.100	1.180	7.0
Manufacturing class	13.206	13.184	-0.022	-0.2
Blend price	14.953	15.400	0.447	3.0
Quantities (million cwt.)				
Fluid class	30.51	30.12	-0.39	-1.3
Manufacturing class	34.37	36.70	2.33	6.8
Total	64.88	66.82	1.94	3.0
Welfare ² (\$million)				
Compact producers ³			29.43	3.0
Compact fluid consumers ⁴			-35.77	-6.9

1. 1999 base year.
2. The difference between gains in producer surplus and losses in fluid consumer surplus is not deadweight loss because of the Compact's effects on producers and consumers outside the Compact region. We calculate these effects in Table 3.
3. Percentage change is change in producer surplus as a share of revenue.
4. Percentage change is change in consumer surplus as a share of expenditure.

Table 3. Effects of the Compact on the Rest of the Country¹

	No Compact ²	Compact	change	%change
California				
Blend price (\$/cwt.)	13.472	13.45	-0.022	-0.16
Production (million cwt.)	304.57	304.08	-0.49	-0.16
Producer surplus (\$million)			-6.56	
Wisconsin				
Blend price	13.882	13.86	-0.022	-0.16
Production	228.34	227.99	-0.35	-0.16
Producer surplus			-4.92	
Minnesota				
Blend price	14.012	13.99	-0.022	-0.15
Production	93.87	93.73	-0.14	-0.15
Producer surplus			-2.02	
U.S. except New England				
Blend price	14.358	14.34	-0.022	-0.15
Production	1,562.63	1,560.29	-2.34	-0.15
Producer surplus			-33.67	
Fluid consumer surplus ³ (\$million)			11.36	
U.S. manufacturing consumer surplus ⁴ (\$million)			23.08	

1. 1999 base year.

2. We simulate the No Compact scenario by raising class prices and producer prices by \$0.022 (see Table 2).

3. Fluid use in the United States was 556.74 million cwt. in 1999. We subtract New England fluid use of 30.12 million cwt. (Table 2) to get non-Compact fluid consumption of 526.63 million cwt.

4. Consumption of manufacturing milk in the United States was 1070.36 million cwt. in 1999.

Table 4. Effects on NY-NJ Producers and Consumers of Adding NY-NJ to the Compact¹

	No Contagion	Contagion	change	%change
Prices (\$/cwt.)				
Fluid class	16.820	17.780	0.960	5.7
Manufacturing class ²	13.284	13.255	-0.029	-0.2
Blend price	14.700	15.010	0.310	2.1
Quantities (million cwt.)				
Fluid class	46.69	46.16	-0.53	-1.1
Manufacturing class	69.92	72.90	2.98	4.3
Total	116.61	119.06	2.45	2.1
Welfare ² (\$million)				
NY-NJ producer ³			36.53	2.1
NY-NJ fluid consumer ⁴			-44.57	-5.7

1. 1999 base year.
2. The difference between gains in producer surplus and losses in fluid consumer surplus is not deadweight loss because of Compact's effects on producers and consumers outside the Compact region. We calculate these effects in Table 5.
3. Percentage change is change in producer surplus as a share of revenue.
4. Percentage change is change in consumer surplus as a share of expenditure.

Table 5. Effects on the Rest of the Country of Adding NY-NJ to the Comapact¹

	No Contagion	Contagion	change	%change
California				
Blend price (\$/cwt.)	13.450	13.421	-0.029	-0.22
Production (million cwt.)	304.08	303.41	-0.667	-0.22
Producer surplus (\$ million)			-8.96	
Wisconsin				
Blend price	13.860	13.831	-0.029	-0.21
Production	227.99	227.50	-0.485	-0.21
Producer surplus			-6.72	
Minnesota				
Blend price	13.990	13.961	-0.029	-0.21
Production	93.73	93.53	-0.198	-0.21
Producer surplus			-2.76	
New England				
Blend price	15.4	15.384	-0.016	-0.11
Production	66.82	66.75	-0.070	-0.11
Producer surplus			-1.08	
U.S. except NY-NJ ³				
Blend price	14.355	14.326	-0.029	-0.21
Production	1,510.50	1507.40	-3.103	-0.21
Producer surplus			-43.61	
Fluid consumer surplus ⁴ (\$ million)			13.87	
U.S. manufacturing consumer surplus ⁵ (\$million)			31.57	

1. 1999 base year.

2. We calculate the effect of NY-NJ on the New England blend price as \$0.029 times 0.55, the share of New England's milk sold to manufacturing uses.

3. Including New England. Since New England produces less than five percent of non-NY-NJ production, the smaller effect on the New England blend price lowers the effect on all non-NY-NJ producers by less than one-tenth of a cent.

4. Fluid use in the United States was 556.74 million cwt. in 1999. Fluid consumers within the Compact do not benefit from lower prices. Thus, we subtract New England fluid use of 30.12 and NY-NJ fluid use of 46.69 million cwt. (Table 2) to get non-Compact fluid consumption of 479.94 million cwt.

5. Consumption of manufacturing milk in the United States was 1070.36 million cwt. in 1999.

Footnotes

¹ We do not attribute consumer surplus to different groups beyond the farmgate, and remain agnostic about the distribution of consumer surplus measures among milk processors, retailers, and final consumers. See Cotterill and Franklin, and Bailey (2001) for analysis and discussion of the Compact's effects on retail milk margins and prices.

² Although the details of the FMMO pricing rules have changed over time, the key element of price discrimination remains; the minimum price for milk used in fluid products is set at a premium over the minimum price set for milk used in manufactured dairy products. The changes in FMMO pricing rules do not change this fact, and do not change our results or conclusions. Manchester and Blaney discuss the evolution of the FMMO pricing rules and the current set of pricing rules.

³ Sumner and Wilson document the development of the California system, and Sumner and Wolf model the difference between California and federal milk marketing orders.

⁴ The Compact system also passed federal district court challenges brought by processor groups in January 1998 and again in November 1998 (Northeast Dairy Compact Commission).

⁵ Federal Milk Marketing Order reform resulted in consolidation and realignment of marketing orders starting January 1, 2000, as of which date the FMMO price relevant to the Compact is the announced minimum Class I price for the newly formed Northeast Order, based in Boston, MA. Throughout this paper, we describe and model the Compact as originally legislated, building from the New England order. The realignment of marketing orders does not change our analysis in an important way, requiring only the substitution of the Northeast Order's minimum Class I price for that of the now defunct New England order.

⁶ Payments to producers are made only after adjustments are made to reimburse the Women Infants and Children program, school lunch programs, and other government outlays that may increase due to a higher milk price caused by the Compact. In approving the Compact, Congress did not hold the Commission responsible for a similar compensation to private consumers of fluid milk. See Wang, et al. for the effects of the Compact on WIC.

⁷ Marketing orders actually work with three, four or five classes of milk: one for fluid uses; two or three for soft products such as cottage cheese or ice cream; and one or two for butter, non-fat dry milk, and cheese. Aggregating all the non-fluid use classes into a single class for all manufactured dairy products simplifies the exposition while still capturing the essence of price discrimination.

⁸ Since manufactured dairy products are traded across the country, we use a factor-price equalization argument to argue that the price of manufacturing milk is approximately equal across the country. Alternatively, we can argue that the minimum price formulae for milk used in cheese and in butter and skim powder are the same across all federal orders, so that these prices are equal across regions and highly, positively correlated. Further, the California and federal systems use pricing formulae that are based on prices for the same, publicly traded dairy products. In any case, it is at least approximately true that there is a single price of manufacturing milk across the country, and this is certainly true relative to the wide variation in the price of milk used for fluid products.

⁹ In reality, marketing orders set minimum prices for manufacturing milk according to formulae that take into account the wholesale prices of manufactured dairy product traded in a competitive market. Our assumption that P_m is set by a competitive market is equivalent to assuming that marketing orders set minimum prices that clear markets.

¹⁰ As with the other literature on milk marketing orders, we ignore over-order premiums here. Inclusion of over-order premiums would not change our analysis significantly, and the direction of the Compact's effects would be the same as found here as long as the Compact Class f price is set above the price that would have been paid for Class f milk. To the extent that over-order premiums are paid in the absence of the Compact, our results will overestimate the increase in the Class f price due to the Compact.

¹¹ If minimum prices for manufacturing class milk are at or below support prices, additional sales of milk on the manufacturing market could result in government purchases of manufactured products. We ignore government purchases in this paper.

¹² The lower manufacturing price has a similar effect on producers of manufacturing grade (Grade B) milk, including those located within the Northeast region, since Grade B

and Class m milk are substitutes in manufactured dairy products. This also applies to Grade A producers who are outside both federal and state marketing orders.

¹³ The specific numerical results depend on our choice of base year. We use the most recent data available. The Compact played less of a role in 1998 due to higher FMMO prices. Thus, had we used 1998 as a base year, the effects of the Compact would be smaller in magnitude but in the same direction as our findings.

¹⁴ Note that we use annual quantities and average annual prices, while the FMMO and the Compact both set monthly prices. The monthly fluid class price announced for the New England FMMO actually exceeded \$16.94 in five months in 1999. Since the Compact's minimum price is $\max(\$16.94, \text{FMMO Class I price})$, the average annual Compact price actually exceeded \$16.94 in 1999. Use of annual data also masks the fact that the fixed Class I price is less responsive than the FMMO Class I prices, which are updated monthly and are positively correlated with dairy product prices. We do not consider the implications of such inflexibility in this paper.

¹⁵ The Northeast Compact eventually instituted a complex supply tax and redistribution scheme. Starting in July 2000, \$0.075 per cwt. of all Class I milk is to be withheld from the Compact's revenues and paid into an escrow fund. These funds would then be paid back to producers who increase production by no more than one percent of the previous year's production. Half of the fund is distributed uniformly to all eligible producers, regardless of an individual farm's level of production. The other half is paid to eligible producers on a per hundredweight basis (Northeast Dairy Compact Commission; Bailey (2000)). The scheme does not guarantee success in preventing growth in milk production. If the minimum fluid price set by the Compact is more than \$0.075 greater than the minimum FMMO price, some producers will find it profitable to increase production under the Compact. Moreover, the supply management mechanism introduces yet another distortion, giving perverse incentives to Compact dairy farms by forcing larger and/or growing farms to subsidize smaller farms.

¹⁶ California's milk pricing policy is different than the FMMO system (see California Department of Food and Agriculture, and Sumner and Wolf). However, the formulae used to set minimum prices for manufacturing milk in California, like those for the

FMMO system, are based on the prices of publicly traded manufactured dairy products. Further, the formula used to set fluid class prices in California is approximately equal to the fixed differential formula used by the FMMO. Thus, in measuring the effects of the Compact on the rest of the country, we treat California as any other region under federal regulation.

¹⁷ The model, data, and parameter values used to analyze the effects of Compact expansion are consistent with the model, data, and parameters used to analyze the original Compact. Thus, the sum of the welfare effects in Tables (2) through (5) is equivalent to the welfare effect of a Compact that includes both New England and NY-NJ, relative to a no-Compact scenario.