



*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

*No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.*

## IMPLICATIONS OF RAISING THE NONFAT SOLIDS STANDARDS FOR BEVERAGE MILK

Larry Salathe and J. Michael Price

### Abstract

An econometric model of the dairy industry was used to estimate the effects on farmers, consumers, and taxpayers of nationwide adoption of the California nonfat solids standards for fluid milk. It was estimated that adoption of the California standards would raise farm-level milk prices by 1 to 5 percent in the short run and by 1 to 2 percent in the long run. The average retail price of fluid milk would rise by 9 to 13 cents per gallon. Dairy program costs fall under most scenarios, but could rise if surpluses fall to levels that would trigger increases in the support price.

**Key words:** California standards, consumers, fluid milk, farm income, milk prices, nonfat solids, taxpayer costs

The sharp decline in farm-level milk prices during the last half of 1990 and through mid-1991 caused concerned groups to suggest changes in dairy policy. Proposals made by both producer organizations and policymakers included raising the minimum standards, as specified by the Food and Drug Administration (FDA), for nonfat solids in beverage milk. A House of Representatives bill, H.R. 2837, passed by the Committee on Agriculture on July 16, 1991, would have increased the minimum nonfat solids standard from 8.25 percent for all types of beverage milk to 8.7 percent for whole milk, 10 percent for 2 percent lowfat milk, 11 percent for 1 percent lowfat milk, and 9 percent for skim milk.<sup>1</sup> Similar legislation was also introduced but defeated in the Senate in 1991.

The objective of this study was to estimate the effects on farmers, consumers, and dairy program costs of adopting the California nonfat solids stand-

ards for beverage milk nationally.<sup>2</sup> Previous studies have tended to focus on the change in retail fluid milk prices, consumption of fluid milk, utilization of nonfat solids, and fluid milk processing costs that would occur from a change in nonfat solids standards for beverage milk (Jacobson; Maes; USDA 1984). These studies, however, did not examine the impacts on farm-level milk prices, farm income, or the cost of the dairy price support program of higher nonfat solids standards for fluid milk products. Further, no studies have been conducted since California permitted the sale of 1 percent lowfat milk containing at least 11 percent nonfat solids in January, 1990.

This paper is organized as follows. A theoretical framework is presented in the first section. This section presents important assumptions and interrelationships that would be affected by raising the nonfat solids standards. The next two sections outline procedures used to develop estimates of the increase in fluid milk prices and consumption of nonfat solids caused by adopting the California nonfat solids standards for beverage milk. Descriptions of the simulation model and the simulations conducted to quantify the impacts of the higher nonfat solids standards are presented next. Lastly, the results of the simulations are discussed.

### THEORETICAL MODEL

The model presented in this section was simplified in order to emphasize the primary interrelationships in the dairy industry and how those interrelationships would be affected by higher nonfat solids standards. Milk can be decomposed into three components: butterfat, nonfat solids, and water. Assuming that the value of water is negligible, the price of milk may be expressed mathematically as:

<sup>1</sup> These standards for nonfat solids are identical to those currently in place in California, except that California permits the nonfat solids content of whole milk to range from 8.6 to 8.8 percent provided that total milk solids equal 12.2 percent. The nonfat solids standards contained in H.R. 2837 are referred to as the California nonfat solids standards throughout this paper.

<sup>2</sup> The California fluid milk standards would also establish a higher butterfat standard for whole milk than required by FDA. This aspect of the California standards is not analyzed since it was not contained in the principal House and Senate dairy bills.

Larry Salathe is an Agricultural Economist with the Analysis Staff, and J. Michael Price is an Agricultural Economist with the Economic Research Service in U.S. Department of Agriculture. The authors gratefully acknowledge the helpful comments provided by Richard Fallert, Alden Manchester, John Mengel, Mark Weimar, and anonymous *SJAE* reviewers on earlier versions of this paper. The views expressed herein do not necessarily reflect those of USDA.

$$(1) P_m = \underline{C}_b P_b + \underline{C}_s P_s,$$

where  $P_m$  is the value (price) of milk per unit,  $\underline{C}_b$  is the amount of butterfat in each unit of milk,  $P_b$  is the value (price) of butterfat per unit,  $\underline{C}_s$  is the amount of nonfat solids in each unit of milk, and  $P_s$  is the value (price) of nonfat solids per unit. Underlined coefficients and variables were treated as exogenous.

The prices of butterfat and nonfat solids were determined by the interaction of supply and demand for each product and by government support prices. The available supply of butterfat and nonfat solids may be expressed as:

$$(2) S_s = \underline{C}_s Q_m + \underline{ST}_s,$$

$$(3) S_b = \underline{C}_b Q_m + \underline{ST}_b,$$

where  $S_s$  and  $S_b$  are the amounts of nonfat solids and butterfat produced, respectively,  $\underline{ST}_s$  and  $\underline{ST}_b$  are beginning commercial stocks of nonfat solids and butterfat, respectively, and  $Q_m$  is total milk production. Total milk production was expressed as a function of the farm price of milk,  $P_m$ , and other variables,  $V_m$ ,

$$(4) Q_m = f(P_m, V_m).$$

The demand for nonfat solids and butterfat was segmented into fluid and other uses, because the higher nonfat solids content only applies to fluid milk products. These demand functions are as follows:

$$(5) Q_s = f(P_s, V_s) + Q_{sf},$$

$$(6) Q_b = f(P_b, V_b) + Q_{bf},$$

where  $Q_s$  and  $Q_b$  are the quantities demanded, including demand for commercial stocks, of individual products containing nonfat solids and butterfat, respectively,  $f(P_s, V_s)$  and  $f(P_b, V_b)$  are functions that relate the demand, including that of commercial stockholding, for nonfat solids and butterfat in manufactured dairy products to their respective prices and other variables.  $Q_{sf}$  and  $Q_{bf}$  are the quantities of nonfat solids and butterfat, respectively, used in fluid milk products. These demand relationships linked adoption of the California standards to changes in quantities demanded and to government removals of butterfat and nonfat solids.

The government supports the prices of both butterfat and nonfat solids. This essentially puts a floor on prices of both nonfat solids and butterfat as well as on the price of milk at the farm as implied by equation (1). The effects of government support

prices for nonfat solids and butterfat were represented by the following equations:

$$(7) P_s \geq \underline{SP}_s,$$

$$(8) P_b \geq \underline{SP}_b,$$

where  $\underline{SP}_s$  and  $\underline{SP}_b$  are the support prices of nonfat solids and of butterfat, respectively. Government removals of butterfat and nonfat solids can be calculated using the following equations:

$$(9) R_s = S_s - Q_s,$$

$$(10) R_b = S_b - Q_b,$$

where  $R_s$  and  $R_b$  are government removals of nonfat solids and butterfat, respectively. Of course, government removals in one time period could be sold commercially at some future date or donated if the government chose to do so.

Suppose that the demand and retail price of fluid milk are given by the following equations:

$$(11) Q_f = f(P_f, \underline{V}_f),$$

$$(12) P_f = f(P_m, \underline{V}_p),$$

where  $Q_f$  is the quantity demanded of fluid milk,  $P_f$  is the retail price of fluid milk,  $\underline{V}_f$  are other variables that influence fluid milk demand, and  $\underline{V}_p$  are variables that impact the spread between farm and retail fluid milk prices. Now, if the government is assumed to require that fluid milk processors use more nonfat solids, the amount of nonfat solids and butterfat that would be consumed in fluid milk products may be expressed as:

$$(13) Q_{sf} = \underline{C}_{sf} Q_f,$$

$$(14) Q_{bf} = \underline{C}_{bf} Q_f,$$

where  $\underline{C}_{sf}$  is the amount of nonfat solids in each unit of fluid milk required by the new standard and  $\underline{C}_{bf}$  is the amount of butterfat in each unit of fluid milk. Alternatively, equation (13) can be written in terms of the difference in the amount of nonfat solids required in fluid milk by the new standards and the change in fluid milk consumption under the old and new standards. This mathematical equation is given by:

$$(15) Q_{sf} = \underline{C}_{sf}^o Q_f^o + (\underline{C}_{sf} - \underline{C}_{sf}^o) Q_f^o - (Q_f^o - Q_f) \underline{C}_{sf}^o,$$

where  $\underline{C}_{sf}^o$  is the amount of nonfat solids in each unit of fluid milk under the old standard and  $Q_f^o$  is the amount of fluid milk consumed under the old standard.

The increase in the amount of nonfat solids in each unit of fluid milk increases fluid milk processors' cost of production. These costs were assumed to be passed on to consumers and therefore equation (12) can be re-written as:

$$(16) P_f = f(P_m, V_p) + (P_s + V_c)(C_{sf} - C_{sf}^0),$$

where the second term of this equation gives the added cost, ingredient ( $P_s$ ) and other costs ( $V_c$ ), of processing fluid milk resulting from adoption of the California standards. If these added costs are passed on to consumers, fluid milk consumption will fall, because fluid milk consumption is negatively related to the price of fluid milk (equation 11). Lower fluid milk consumption will reduce consumption of butterfat (equations 6 and 14) and offset some of the initial increase in consumption of nonfat solids caused by increasing the nonfat solids standard for fluid milk (equations 5 and 13).

As the above theoretical model points out, the net impact of adoption of the California standards on farm-level milk prices depends on many factors, including the baseline level of government purchases of nonfat solids, the elasticity of supply of milk, the elasticities of demand for fluid milk, butterfat, and nonfat milk solids, the mandated increase in nonfat solids in fluid milk, and the cost of nonfat solids. However, milk prices may not change very much if baseline government purchases of nonfat solids exceed the increase in demand for nonfat solids caused by the higher nonfat solids standards, because the increase in consumption of nonfat solids will be offset by reduced government removals. On the other hand, if baseline government removals are small, the higher standards could lead to significant increases in the price of nonfat solids and in the farm price of milk.

### IMPLICATIONS FOR NONFAT SOLIDS CONTENT OF BEVERAGE MILK

To determine the impact of adoption of the California standards, the potential increase in consumption of nonfat solids must be estimated. This requires the comparison of the current nonfat solids content of beverage milk with the level mandated by the California standards.

Cow's milk annually averages about 3.67 percent butterfat, 8.60 percent nonfat solids, and 87.73 percent water, although butterfat and nonfat solids content varies seasonally and by breed (Goold). All the solids in milk other than butterfat are designated as nonfat solids; these include protein, lactose, and ash (calcium, etc.).

Table 1. Nonfat Solids Content of Selected Beverage Milk Products

Product	Butterfat Content (column (a))	Nonfat Solids Content <sup>a</sup> (column (b))	California Standard
----- percentage -----			
Whole milk	3.25	8.64	8.60-8.70
Lowfat milk			
2%, regular	2.00	8.75	10.00
1%, regular	1.00	8.84	11.00
Skim milk	0.30	8.90	9.00

<sup>a</sup>Column (b) =  $8.60 / ((100 - 3.67 + \text{column (a)}) \times 0.01)$ .

The nonfat solids content of cow's milk can be increased by removing some of the butterfat or by adding concentrated nonfat solids. The nonfat solids content of cow's milk cannot be legally lowered by the addition of water and the resultant product sold as fluid milk.

Under FDA standards, whole milk must contain at least 3.25 percent butterfat and 8.25 percent nonfat solids by total volume. Because the butterfat standard for whole milk is below that of cow's milk, milk processors can legally remove a portion of the butterfat in cow's milk. By reducing the butterfat content of cow's milk, the nonfat solids content of milk increases in percentage terms. Table 1 gives the implied nonfat solids content of various fluid beverage products, assuming cow's milk is 8.60 percent nonfat solids and 3.67 percent butterfat, and the minimum nonfat solids content required by the California standards. As shown in Table 1, adoption of the California nonfat solids standards would have its greatest impact on the nonfat solids content of 1 and 2 percent regular (unfortified) lowfat milk products.

### ESTIMATION OF INITIAL-ROUND IMPACT ON FLUID MILK PRICE

This section describes the procedure used to estimate the change in the retail price of fluid milk caused by adoption of the California standards. The output of this procedure was an estimate of the change in the retail price of fluid milk, given the price of nonfat dry milk. This initial estimate of the change in the retail price of fluid milk was supplied to a simulation model of the dairy sector, which calculates the change in fluid milk consumption and other dairy sector variables resulting from adoption of the California standards.

As the earlier section pointed out, raising the nonfat solids content of beverage milk would increase

Table 2. Initial Estimated Change in Cost of Beverage Milk Products, 1992

			Lowfat <sup>a</sup>				
	Units	Whole	2% Reg.	2% Fort.	1% Reg.	1% Fort.	Skim <sup>b</sup> reg.
Solids nonfat content:							
Current sales	Percent	8.64	8.75	9.52	8.84	9.34	8.90
New standard	Percent	8.70	10.00	10.00	11.00	11.00	9.00
Change	Percent	.06	1.25	.48	2.16	1.66	.10
Additional nonfat solids <sup>c</sup>	Lbs. / gal.	.005	.108	.041	.186	.143	.009
Cost of additional solids <sup>d</sup>	\$ / gal.	.005	.109	.042	.188	.144	.009
Cost of additional processing <sup>e</sup>	\$ / gal.	.018	.018	.000	.018	.000	.018
Total Additional cost	\$ / gal.	.023	.127	.042	.206	.144	.027
Percent of total milk consumed	Percent	31.7	34.1	3.8	6.8	0.9	8.2
Net impact on retail price	\$ / gal.	.007	.043	.002	.014	.001	.002

<sup>a</sup>Nonfat solids content of 1 and 2 percent fortified lowfat milk estimated from 1984 USDA study.

<sup>b</sup>Fortified skim milk is not included because nonfat solids content was estimated to exceed California standard.

<sup>c</sup>Computed by multiplying the percentage increase in solids content by 8.6 pounds per gallon and dividing the result by 100.

<sup>d</sup>Assumes that nonfat dry milk sells for \$0.973 per pound and contains 96.2 percent nonfat solids.

<sup>e</sup>Based on earlier studies by Novakovic and Aplin and Jacobson and adjusted for inflation using the GNP deflator since those studies were undertaken.

the amount of nonfat solids in fluid milk and would increase the cost of processing raw milk into fluid beverage milk. The increase in processing cost includes the cost of the additional nonfat solids and the cost of additional equipment and labor needed for blending the final product. Fluid milk processors were assumed to pass these added costs on to fluid milk consumers (equation 16). This assumption seems valid because the demand for fluid milk has been shown to be very inelastic (Haidacher et al.).

A multiple step procedure was used to calculate the added cost of fluid milk products. These steps are laid out in Table 2. In step 1, the increase in nonfat solids content per pound of milk was multiplied by 8.6, the number of pounds in one gallon of milk. In step 2, the amount of nonfat solids added per gallon of milk was multiplied by the price of nonfat dry milk adjusted for the average nonfat solids content (96.2 percent) of nonfat dry milk. In step 3, the cost of additional nonfat solids was added to the cost of additional labor and equipment needed for blending the additional nonfat solids. In step 4, the increased cost of each fluid milk product calculated in step 3 was multiplied by the share of total milk sales in each product category. Lastly, an overall, or average, estimate of the effect of the higher nonfat solids

standard on the retail price of fluid milk was determined by summing the calculations in step 4 across all fluid milk product categories.

The increase in nonfat solids content varied from 0 for fortified skim milk, whose solids nonfat content was estimated to exceed the California standard, to .186 pounds per gallon for regular 1 percent milk. Assuming the price of nonfat dry milk is \$0.973 per pound, the California standards would result in an average increase in the retail cost of beverage milk products of 6.9 cents per gallon in 1992, the weighted sum of the increases in the cost of fluid milk products across all fluid milk product categories.<sup>3</sup> Slightly more than 60 percent of the increase in the retail cost of beverage milk was accounted for by the higher nonfat solids content that would be required for regular 2 percent milk; 1 percent regular milk accounted for about 20 percent of the increase in the cost of beverage milk, with all other fluid milk categories accounting for the remainder.

### SIMULATION MODEL

The preceding calculations merely measured the average change in the retail price of fluid milk caused by the higher nonfat standards given the price of nonfat dry milk. As shown by the theoretical model,

<sup>3</sup>The price of \$0.973 per pound, the current government purchase price, for nonfat dry milk was used to illustrate the method of estimating the change in the retail price of fluid milk caused by adopting the California standards. Actual prices of nonfat dry milk could be higher. In addition, adoption of the California standards could also increase farm-level milk prices, which could lead to even higher retail fluid milk prices. Actual estimates of change in retail price of milk and the price of nonfat dry milk were derived using an econometric model of the dairy sector.

the higher nonfat solids standard could have more widespread effects on the dairy industry. An annual econometric model of the U.S. dairy sector and the procedures illustrated earlier were used to estimate the effects of nationwide adoption of the California nonfat solids standards for beverage milk on farmers, consumers, and taxpayers.

The dairy model is one component of USDA's Food and Agricultural Policy Simulator (FAPSIM), an econometric model of the U.S. agricultural sector.<sup>4</sup> The dairy model consists of approximately 100 equations. For milk, the model estimates total production, fluid use, farm, wholesale, and retail prices, and Commodity Credit Corporation (CCC) net removals. FAPSIM includes detailed models for cheese, butter, nonfat dry milk, frozen milk products, and evaporated and condensed milk. For each of these dairy products, the model estimates production, consumption, price, commercial and CCC stocks, and CCC net removals (where applicable). In addition, the model estimates farm cash receipts from milk sales and the net cost of the dairy price support program. The entire system of equations is solved simultaneously using a Gauss-Seidel algorithm.

The size of the dairy model prohibits an in depth discussion of the model's structure here. However, the theoretical model presented earlier identifies the more important relationships for quantifying the effects of increasing the nonfat solids standard for fluid milk. The model's parameters and basic structure pertaining to these important relationships and how the model was altered for the purpose of simulating the effects of the higher nonfat-solids standard are discussed below.

Several steps were involved in each simulation. In step 1, the increase in nonfat solids consumption implied by the higher nonfat solids standard and the increase in the retail price of fluid milk were calculated using the procedures discussed earlier. An estimate of the change in nonfat solids consumption was obtained by multiplying the change in nonfat solids in each beverage product by sales in each product category subject to the higher standard. These calculations were performed outside of the simulation framework.

In step 2, two equations were added to the simulation model to account for changes in the price of nonfat solids and fluid milk consumption as the model iterates to a final solution. The first equation altered the model's estimate of the increase in the

retail price of fluid milk if the model's estimate of the price of nonfat dry milk differed from that assumed in step 1. This equation is:

$$(17) \Delta P_f = \Delta P_{f0} + (P_s - P_{s0})C_{sf},$$

where  $\Delta P_f$  is the model-calculated increase in the retail price of fluid milk,  $\Delta P_{f0}$  is the increase in the retail price of fluid milk calculated in step 1, and  $P_{s0}$  is the price of nonfat dry milk in step 1.

The second equation altered the model's estimate of the increase in nonfat solids consumption if the model's estimate of fluid milk consumption differed from that used to calculate the increase in nonfat solids consumption in step 1. This equation is:

$$(18) \Delta Q_{sf} = \Delta Q_{sf0} - (C_{sf} - C_{sf0})(Q_{f0} - Q_f),$$

where  $\Delta Q_{sf}$  is the model-calculated increase in nonfat solids consumption and  $\Delta Q_{sf0}$  is the increase in nonfat solids consumption calculated in step 1. The term  $C_{sf0}(Q_f - Q_{f0})$  was excluded from equation 22, because the FAPSIM dairy model endogenously determined the amount of nonfat solids available for manufacturing based on the level of fluid milk consumption and the historical nonfat solids content of fluid milk. Therefore, the model need only account for the change in nonfat solids content multiplied by the change in fluid milk consumption.

Each simulation began by feeding the initial increases in nonfat solids consumption and the retail price of fluid milk into the model. The higher nonfat solids consumption was depicted in the model by an increase in demand for nonfat dry milk as reflected by a shift in the demand curve from D to D' in Figure 1. This raised the price of nonfat dry milk and lowered CCC net removals. How much nonfat dry milk prices increase depended on three factors. These factors were the elasticity of demand for nonfat dry milk, the level of CCC removals in the baseline, and how much additional milk was processed into nonfat dry milk as prices increase.

The FAPSIM dairy model assumes that CCC net removals are quite responsive to changes in price if prices are near the CCC support price. This is reflected in Figure 1 by making the demand curve for nonfat dry milk more elastic once price falls below the CCC resale price, 110 percent of the purchase price. The demand curve for nonfat dry milk becomes perfectly elastic at the CCC support price,

<sup>4</sup>Previous publications (Gadson et al., Salathe et al.) have documented the structure of the FAPSIM's dairy sector component. Readers wishing more recent information on FAPSIM or the simulation results are invited to contact the authors.

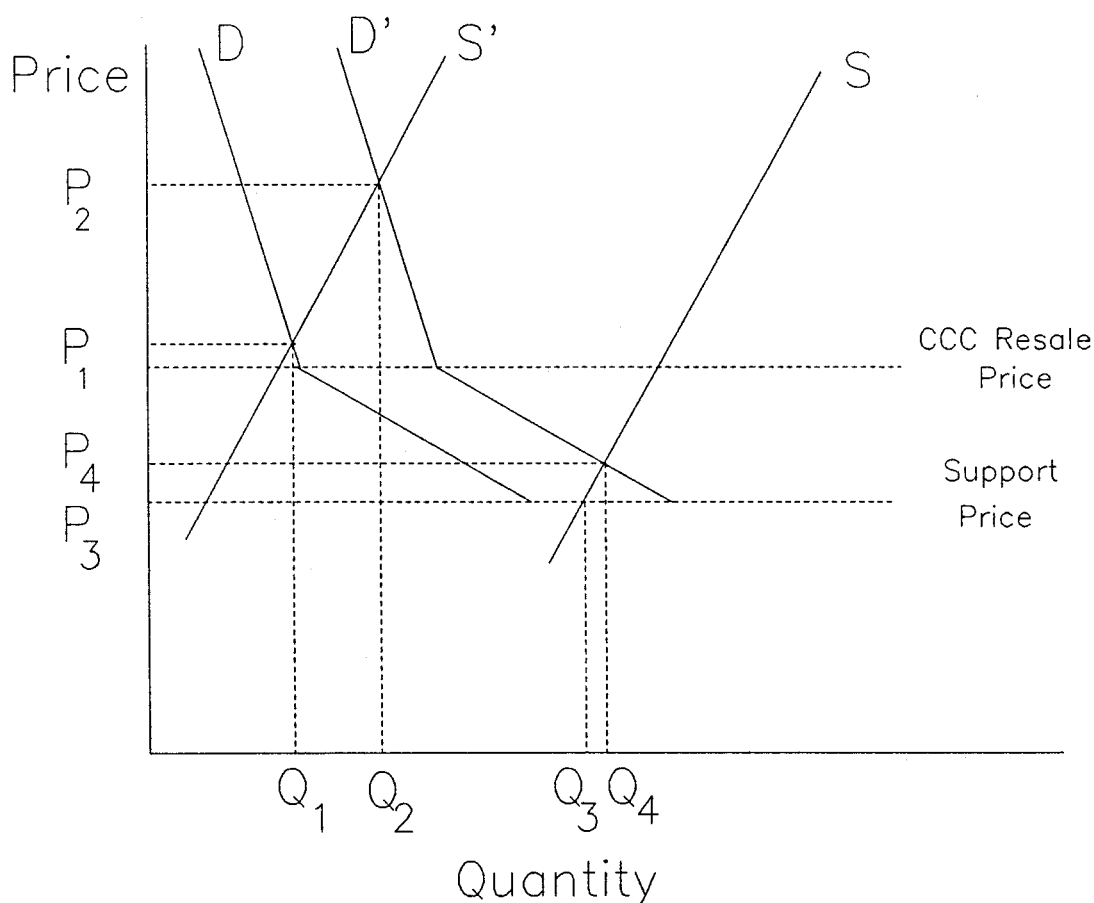


Figure 1. Market for Nonfat Dry Milk

because all available supplies may be sold to the CCC at that price.<sup>5</sup>

Figure 1 shows the importance of the level of government removals in determining the effect of an increase in demand on nonfat dry milk prices. If baseline removals are substantial, a shift in demand for nonfat dry milk may not lead to much of an increase in nonfat dry milk prices, as reflected by the increase in price from  $P_3$  to  $P_4$  in Figure 1. On the other hand, an increase in demand for nonfat dry milk would have a much larger impact on the price of nonfat dry milk if baseline prices are well above the support level and government stockpiles are small, as they are currently. This situation is reflected by the increase in nonfat dry milk prices from  $P_1$  to  $P_2$  in Figure 1.

In the simulation model, per capita consumption of nonfat dry milk was determined by the ratio of the

wholesale price of nonfat dry milk to the retail price of fluid milk and real per capita disposable income. Per capita consumption of fluid milk and cheese were expressed as a function of real per capita disposable income and the real retail price of the product. Per capita consumption of butter was negatively related to the ratio of the retail price of butter to the retail price of margarine and the Consumer Price Index for food-away-from-home, because a significant amount of butter is consumed in restaurants and other establishments. The model's demand equations indicated that a 10-percent increase in the wholesale price of nonfat dry milk caused an 8-percent decline in the consumption of nonfat dry milk, while a 10-percent increase in the retail price of fluid milk reduced the consumption of fluid milk by 2.5 percent. The model's retail demand elasticities for butter and cheese were -0.3 and -0.6, respectively.

<sup>5</sup>If the government elected to sell its stocks when market prices reached the CCC resale price, the supply curve in Figure 1 would become more elastic at prices near or slightly above the CCC resale price. This situation is not depicted in Figure 1, because CCC stocks of nonfat dry milk were assumed to remain isolated from the commercial market under all scenarios.

These elasticities are similar to those estimated by other researchers (Haidacher et al.).

Changes in the prices of butter, cheese, and nonfat dry milk affect farmers by changing the price paid by handlers for manufacturing milk. Because Federal order prices are tied to the price of manufacturing milk, the producer price of all milk is affected by changes in the prices of these products. The model's parameters indicated that each one cent increase in the wholesale price of butter, cheese, and nonfat dry milk increased the manufacturing milk price by 2, 6, and 3 cents per hundredweight, respectively. Farm milk prices increased less than what technical coefficients (100 pounds of milk yields about 10 pounds of cheese or 4 pounds of butter and 9 pounds of nonfat dry milk) would suggest because manufacturing milk is used to produce several products, all of which contribute to the value of milk.

The model contains equations to estimate dairy cow slaughter, additions to the dairy cow herd, dairy cow numbers, milk production per cow, total milk production, milk fed to calves, milk sold to plants, and the supply of milk eligible for fluid consumption. The coefficients of these equations implied that a 10-percent increase in the price of milk, holding all other variables constant, would lead to a 1-percent increase in milk production the first year. A 10-percent increase in the farm price of milk over a 4-year period would result in about a 5-percent increase in milk production by the fourth year.

The milk supply is initially allocated to fluid milk, condensed and evaporated milk, and frozen milk products as determined by the demand for these products. The remaining milk supply is allocated to cheese, butter, and nonfat dry milk, based on the relative profitability of producing cheese compared to butter and nonfat dry milk. Thus, a higher price for nonfat dry milk increases the amount of milk used in butter/powder production and lowers the amount of milk used in cheese production.

## DESCRIPTION OF MODEL SIMULATIONS

Each model simulation began by using the procedures described earlier to estimate the increase in nonfat solids consumption and the increase in the retail price of fluid milk implied by the California nonfat solids standards for 1992-95. Those results were entered into the simulation model and the model's final solution was compared with baseline model projections to determine the effect of the higher nonfat solids standards. Due to the sensitivity of the simulation results to CCC net removals of nonfat dry milk, the model was simulated under different levels of CCC net removals.

Under a high net removal baseline, or one in which CCC net removals of nonfat dry milk exceed the increase in nonfat solids consumption caused by the higher California standards, farm-level milk prices are not expected to increase substantially. However, even though farm milk prices may not increase substantially, the higher nonfat solids standards could still lead to significantly higher farm income by reducing assessments on milk marketings mandated by the Food, Agriculture, Conservation, and Trade Act of 1990 (FACT Act). The FACT Act mandates assessments on milk marketings to cover the cost of CCC net removals in excess of 7 billion pounds milk equivalent, total solids basis.

Under a low net removal baseline, or one in which CCC net removals of nonfat dry milk are far below the increase in consumption of nonfat solids caused by the California standards, farm-level milk prices are expected to increase significantly. In addition, the higher nonfat solids standard could trigger an increase in the support price required by the FACT Act of at least \$0.25 per hundredweight, if CCC net removals are projected to fall below 3.5 billion pounds milk equivalent, total solids basis, the following year. The FACT Act also requires that the support price be reduced by at least \$0.25 per hundredweight, but by not more than \$0.50 per hundredweight, if CCC removals are projected to exceed 5 billion pounds, total solids basis. In no case, may the support price be set below \$10.10 per hundredweight, the baseline support price.

Four simulations were selected to provide an indication of the sensitivity of the results to widely different baseline assumptions for total CCC net removals of dairy products and net removals of nonfat dry milk. The various baselines reflect final model solutions following adjustment in the model's intercept coefficients using add factors. This approach allowed alternative baselines to be generated without altering the responses of the model's supply and demand equations to changes in prices or other endogenous variables.

Under the first simulation, baseline CCC net removals of all dairy products equalled 3.5 billion pounds milk equivalent, total solids basis, each year, and CCC net removals of nonfat dry milk equalled 100 million pounds each year. Total CCC removals rose to 7 billion pounds with net removals of nonfat dry milk of 100 million pounds each year under the baseline for simulation 2. Under the third simulation, baseline total net removals and net removals of nonfat dry milk equalled 7 billion pounds and 350 million pounds each year, respectively. Total CCC removals were increased to 10 billion pounds with CCC removals of nonfat dry milk held at 350 million



Table 3. Projected Sales in All States Excluding California

	1982	1989	1992	1993	1994	1995
-----billion pounds-----						
Whole milk	26.7 (52.4)	20.0 (37.9)	17.0 (31.7)	15.9 (29.6)	14.8 (27.5)	13.7 (25.2)
2%, regular	11.0 (21.6)	15.9 (30.2)	18.3 (34.1)	19.1 (35.4)	19.8 (36.7)	20.6 (38.0)
2%, fortified	1.9 (3.7)	2.0 (3.8)	2.1 (3.8)	2.1 (3.8)	2.1 (3.9)	2.1 (3.9)
1%, regular	2.4 (4.7)	3.2 (6.1)	3.6 (6.8)	3.7 (6.9)	3.9 (7.2)	4.0 (7.4)
1%, fortified	.8 (1.6)	.6 (1.1)	.5 (.9)	.5 (.8)	.4 (.8)	.4 (.7)
Skim, regular	1.7 (3.3)	3.5 (6.7)	4.4 (8.2)	4.7 (8.7)	5.0 (9.2)	5.3 (9.7)
Skim, fortified	.5 (1.1)	.9 (1.8)	1.1 (2.1)	1.2 (2.2)	1.2 (2.3)	1.3 (2.4)
Total	44.9 (88.4)	46.2 (87.6)	47.0 (87.5)	47.1 (87.5)	47.3 (87.4)	47.4 (87.4)

\*Numbers in parentheses denote share of total U.S. sales accounted for by the respective product category. Shares do not sum to 100 because California's sales are excluded.

pounds each year under the baseline for simulation 4. In all simulations, the initial increases in consumption of nonfat solids and the retail price of fluid milk were identical, and government stocks were assumed to remain isolated from the commercial market. The simulated outcomes differed because of differences in the baseline levels of CCC net removals and policy responses that would be mandated by the FACT Act.

Baseline estimates of consumption of each beverage milk product provided the basis for estimating the initial effects of nationwide adoption of the California nonfat solids standards on nonfat solids consumption and on the retail price of fluid milk products. These baseline consumption estimates were developed for California and all other states by extending per capita consumption trends for the period 1982-89 through to 1995 (Table 3). An initial estimate of the increase in nonfat solids consumption was derived by multiplying projected consumption of each fluid beverage product in all states, excluding California, by the estimated increase in nonfat solids required by the California standards. The initial increase in nonfat solids consumption was estimated to be 343 million pounds in 1992, which is equivalent to 357 million pounds of nonfat dry milk or 2.5 billion pounds milk equivalent, total solids basis (USDA 1991). About 90 percent of the increase in nonfat solids consumption was accounted for by

increases in nonfat solids that would be required in regular 1 and 2 percent lowfat milk products.

The initial increase in nonfat dry milk consumption rose to 391 million pounds or 2.7 billion pounds milk equivalent, total solids basis, for 1995. The increase in nonfat dry milk consumption caused by the higher nonfat solids standards between 1992 and 1995 reflected the baseline forecast of continued increases in lowfat milk consumption at the expense of whole milk. Because more nonfat solids must be added to lowfat milk than to other fluid milk products, continued increases in lowfat milk consumption raised the amount of nonfat solids that would be required by adoption of the California standards.

## SIMULATION RESULTS

Each simulation began with 1992 and ran through 1995. The model's projections for milk production and effective all-milk price over the simulation period are presented in Figures 2 and 3. Because of the large number of variables, simulations, and years involved, only changes in selected variables and for selected years are discussed below and presented in Table 4. Generally, the discussion and presentation of the impacts are limited to the first year impact (1992) and the fourth year impact (1995). By the fourth year, milk production responded fully to the initial increase in milk prices as the adjustment period was long enough for dairy farmers to increase the number of heifers and bring those additional heifers into the dairy herd.

### Simulation 1

Under a baseline with net removals of all dairy products of 3.5 billion pounds and net removals of nonfat dry milk of 100 million pounds each year, the simulation model projected that adoption of the California standards would trigger minimum increases in the support price of \$0.25 per hundredweight in the first and second years following adoption. Adoption of the standards combined with the low level of baseline CCC removals of dairy products caused the all-milk price to increase by \$0.58 per hundredweight in 1992 and \$0.27 per hundredweight in 1995. These price increases greatly exceeded those projected for the remaining simulations, reflecting the relatively low removals under the baseline. Farm cash receipts increased by \$933 million in 1992 and by \$688 million 1995.

In response to the higher price for milk, milk production increased by 0.6 billion pounds in 1992 and sustained increases in milk prices resulted in an increase in milk production of 2.4 billion pounds in 1995 (Figure 2). By 1995, higher milk production and lower fluid milk consumption caused projected

Table 4. Simulated Changes in Dairy Sector Variables<sup>a</sup>

	Units	Simulation 1		Simulation 2		Simulation 3		Simulation 4	
		1992	1995	1992	1995	1992	1995	1992	1995
Milk production	Bil. lbs.	.62 (0.6)	2.42 (2.4)	.39 (0.3)	1.26 (0.8)	.13 (0.1)	.68 (0.4)	.24 (0.2)	1.02 (0.7)
Fluid milk production	Bil. lbs.	-.83 (-1.4)	-.63 (-1.1)	-.70 (-1.2)	-.59 (-1.0)	-.53 (-.9)	-.56 (-1.0)	-.53 (-.9)	-.55 (-.9)
Total CCC net removals	Bil. lbs.	-.15 (-4.1)	.95 (26.8)	-.86 (-12.3)	-.45 (-6.5)	-1.70 (-24.3)	-1.21 (-17.3)	-1.59 (-15.8)	-.86 (-8.7)
Farm all-milk price	\$/cwt.	.58 (5.0)	.27 (2.3)	.36 (3.1)	.19 (1.7)	.12 (1.0)	.14 (1.2)	.11 (1.0)	.12 (1.0)
Producer assessments	\$/cwt.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	-.11 (-34.1)	-.06 (-18.8)
Effective all-milk price	\$/cwt.	.58 (5.0)	.27 (2.3)	.36 (3.1)	.19 (1.7)	.12 (1.0)	.14 (1.2)	.22 (1.9)	.18 (1.6)
CCC nonfat dry milk removals	Mil. lbs.	-100 (-100.0)	-50 (-50.2)	-100 (-100.0)	-100 (-100.0)	-257 (-73.4)	-197 (-56.3)	-249 (-70.9)	-174 (-49.7)
CCC cheese removals	Mil. lbs.	-72 (-100.0)	-43 (-63.8)	-136 (-68.1)	-117 (-58.4)	-46 (-23.1)	-80 (-40.1)	-45 (-8.7)	-73 (-14.2)
CCC butter removals	Mil. lbs.	141 (56.6)	194 (78.0)	130 (26.4)	156 (31.9)	62 (21.2)	107 (36.4)	67 (22.9)	120 (40.8)
Nonfat dry milk production	Mil. lbs.	244 (23.2)	349 (30.0)	242 (23.0)	293 (25.2)	110 (10.5)	198 (17.0)	119 (11.3)	222 (19.1)
Cheese production	Mil. lbs.	-123 (-2.0)	-70 (-1.0)	-161 (-2.6)	-137 (-2.1)	-55 (-.9)	-94 (-1.4)	-53 (-.8)	-85 (-1.3)
Butter production	Mil. lbs.	125 (10.1)	185 (12.6)	122 (9.8)	151 (11.9)	56 (4.5)	102 (8.0)	61 (4.9)	115 (9.1)
Nonfat dry milk consumption	Mil. lbs.	335 (42.7)	397 (45.0)	335 (42.6)	393 (44.5)	357 (65.8)	395 (62.4)	358 (65.9)	396 (62.5)
Cheese consumption	Mil. lbs.	-49 (-.8)	-28 (-.4)	-25 (-.4)	-20 (-.3)	-8 (-.1)	-14 (-.2)	-8 (-.1)	-12 (-.2)
Butter consumption	Mil. lbs.	-15 (-1.6)	-10 (-.9)	-8 (-1.1)	-6 (-.7)	-6 (-.6)	-6 (-.6)	-6 (-.6)	-5 (-.5)
Price of nonfat dry milk	Cents/lb.	9.0 (8.9)	2.1 (2.0)	8.3 (8.2)	2.7 (2.7)	2.8 (2.8)	2.2 (2.1)	2.7 (2.7)	1.9 (1.9)
Price of cheese	Cents/lb.	5.4 (4.5)	3.3 (2.7)	2.7 (2.3)	2.3 (2.0)	.9 (0.8)	1.6 (1.3)	.9 (0.7)	1.4 (1.2)
Price of butter	Cents/lb.	2.8 (3.5)	2.8 (3.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Price of fluid milk	Cents/gal	13.0 (5.7)	10.6 (4.4)	11.3 (4.8)	9.9 (4.6)	8.5 (3.6)	9.4 (3.8)	8.5 (3.6)	9.2 (3.7)
Farm cash receipts	Mil. \$	933 (5.4)	688 (3.9)	581 (3.3)	441 (2.5)	188 (1.1)	289 (1.6)	356 (2.0)	388 (2.2)
Dairy program costs	Mil. \$	-50 (-24.4)	62 (32.3)	-142 (-25.9)	-109 (-20.9)	-245 (-39.2)	-199 (-32.2)	-70 (-10.4)	-73 (-11.0)
Consumer expenditures for dairy products	Mil. \$	920 (1.9)	634 (1.2)	757 (1.6)	570 (1.1)	485 (1.0)	514 (0.9)	479 (1.0)	499 (0.9)

<sup>a</sup>Numbers in parentheses denote percentage change from baseline levels.

Simulation 1—Baseline purchases consist of 3.5 billion pounds milk equivalent, total solids basis, of all dairy products and 100 million pounds of nonfat dry milk.

Simulation 2—Baseline purchases consist of 7.0 billion pounds milk equivalent, total solids basis, of all dairy products and 100 million pounds of nonfat dry milk.

Simulation 3—Baseline purchases consist of 7.0 billion pounds milk equivalent, total solids basis, of all dairy products and 350 million pounds of nonfat dry milk.

Simulation 4—Baseline purchases consist of 10.0 billion pounds milk equivalent, total solids basis, of all dairy products and 350 million pounds of nonfat dry milk.

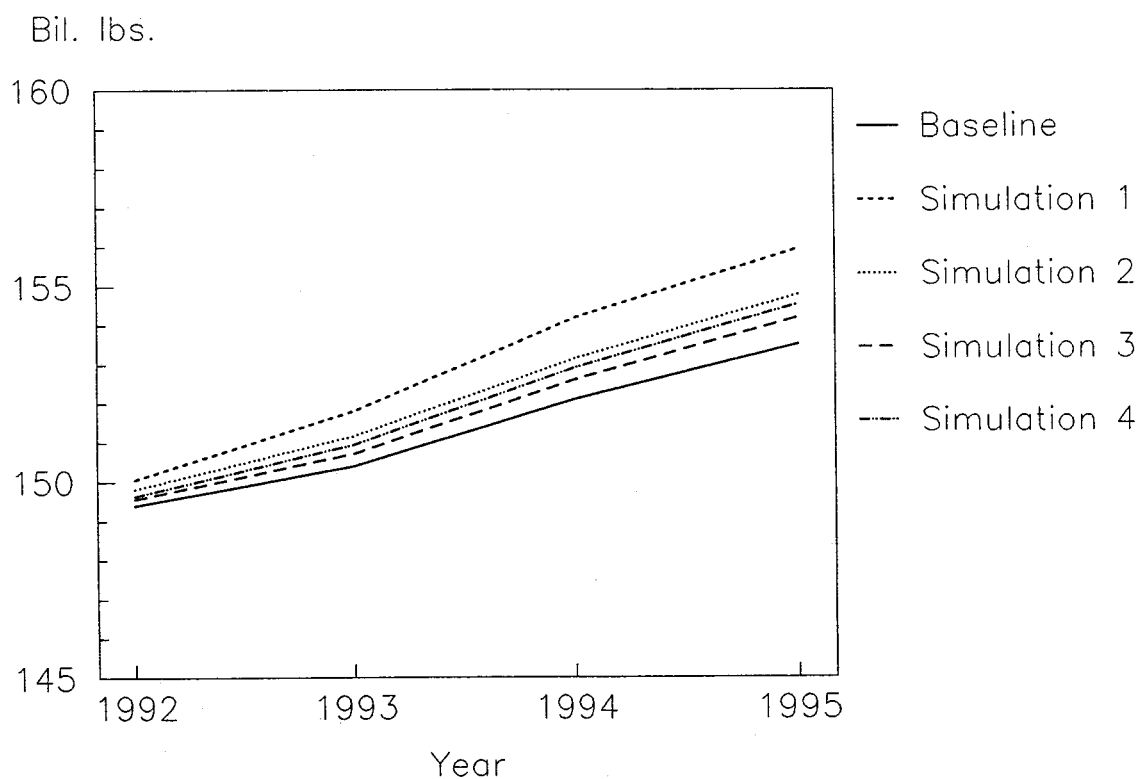


Figure 2. Estimates of Milk Production

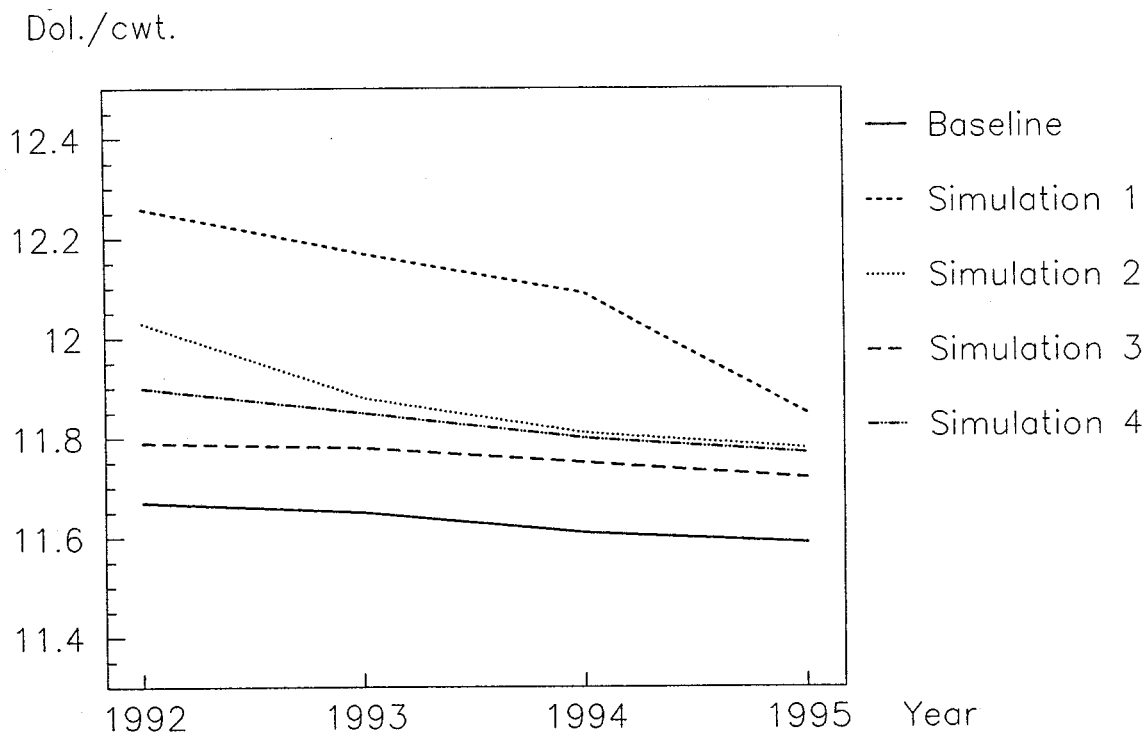


Figure 3. Estimates of Effective All-Milk Price

CCC net removals to exceed 5.0 billion pounds, triggering a minimum reduction in the support price of \$0.25 per hundredweight.

Adoption of the California standards raised the price of nonfat dry milk by 9.0 cents per pound in 1992. Butter prices also increased reflecting the increase in the support price for manufacturing milk, while cheese prices increased because higher nonfat dry milk and butter prices caused milk to be diverted from cheese to butter/powder production. By 1995, higher milk production about offset the increase in demand for nonfat dry milk brought about by adoption of the nonfat solids standards. As a result, the increase in milk prices in 1995 was almost entirely a reflection of the \$0.25 per hundredweight increase in the support price for manufacturing milk in 1995 (Figure 3).

Dairy program costs declined by \$50 million in 1992. In 1992, lower nonfat dry milk and cheese purchase costs more than offset the higher cost of butter purchases. However, dairy program costs exceeded baseline levels by \$62 million in 1995. In 1995, increases in milk production caused both cheese and butter purchase costs to exceed baseline levels. These higher purchase costs exceeded the savings from reduced purchases of nonfat dry milk.

Consumer expenditures for dairy products increased by \$920 million in 1992 and \$634 million in 1995. The increase in consumer expenditures reflected increases in the retail price of fluid milk as well as increases in the prices of manufactured dairy products. The retail price of fluid milk averaged \$0.13 per gallon higher in 1992 and \$0.11 per gallon higher in 1995.

### Simulation 2

Under a baseline with CCC net removals of 7 billion pounds and nonfat dry milk removals of 100 million pounds each year, the simulation model projected that adoption of the California nonfat solids standards would reduce total CCC removals by 0.9 billion pounds in 1992 and by 0.5 billion pounds in 1995. These declines in CCC net removals would not be enough to trigger an increase in the support price for manufacturing milk under the FACT Act. As a result, milk prices increased less under this simulation than under simulation 1.

Milk prices increase by \$0.36 per hundredweight in 1992 as nonfat dry milk and cheese prices increased by 8.3 and 2.7 cents per pound, respectively. Butter prices remained unchanged in this simulation because butter prices in the baseline were at support levels. In 1995, the all-milk price was projected to increase by \$0.19 per hundredweight, associated

with price increases of 2.7 cents per pound for nonfat dry milk and 2.3 cents per pound for cheese.

The increase in the price of nonfat dry milk in 1995 was about one-third of the increase in 1992, while the increase in the price of cheese in 1995 was only slightly less than that in 1992. Cheese prices declined less than nonfat dry milk prices between 1992 and 1995, because higher nonfat dry milk prices created an incentive to divert milk from cheese to butter/powder production. As milk was diverted from cheese to butter/powder production, cheese prices rose relative to nonfat dry milk prices.

Farmers responded to higher milk prices by expanding production. However, the increase in milk production was considerably less than in simulation 1. Unlike the response in simulation 1, the increase in milk production was not enough to cause net removals to exceed baseline levels, and dairy program costs fell in both 1992 and 1995. In both years, nonfat dry milk and cheese purchase costs fell by enough to offset the cost of additional butter purchases.

### Simulation 3

Under this baseline, CCC net removals of nonfat dry milk (350 million pounds) were about equal to the simulated increase in consumption caused by the higher nonfat solids standards. Thus, nonfat dry milk prices rose only to the extent needed to divert the additional nonfat solids away from the government to commercial channels. Cheese prices also increased moderately as slightly higher nonfat dry milk prices caused moderate amounts of milk to be diverted from cheese production to butter/powder production.

The moderate increases in nonfat dry milk and cheese prices projected under this simulation raised the all-milk price by \$0.12 per hundredweight in 1992 and by \$0.14 in 1995. The increase in milk prices led to a 0.1 billion pound increase in milk production in 1992 and a 0.7 billion pound increase in milk production in 1995. Higher milk prices and milk production caused cash receipts to increase by \$188 million in 1992 and by \$289 million in 1995.

Milk prices increased somewhat more in 1995 than in 1992, despite the greater expansion in milk production in 1995, for two reasons. First, milk production expanded only slightly more in 1995 than in 1992. As a result, the increase in available nonfat solids resulting from more milk production was about equal to the increase in nonfat solids required by adoption of the higher standards. Adoption of the standards required more nonfat solids in 1995 than in 1992, because the baseline assumed consumers continue to expand consumption of lowfat milk

products. Second, higher nonfat dry milk prices caused milk to be diverted from cheese production to butter/powder production in 1992 and following years. This caused cheese prices to increase more in 1995 than in 1992, while nonfat dry milk prices increased somewhat less in 1995. The net impact on milk prices was expected to be positive, because cheese prices impact manufacturing milk prices more heavily than do nonfat dry milk prices.

Consumer expenditures for dairy products increased by about \$500 million in 1992 and 1995 as the retail price of fluid milk averaged about \$0.09 per gallon higher. About 15 percent of the increase in the retail price of fluid milk was due to the increase in farm-level milk prices, while the cost of adding nonfat solids accounted for the remainder.

### Simulation 4

Under a baseline with CCC net removals of all dairy products of 10 billion pounds and net removals of nonfat dry milk of 350 million pounds annually, farm-level milk prices exhibited increases similar to those under the previous simulation. In addition, producer assessments to cover the cost of CCC purchases in excess of 7 billion pounds milk equivalent declined by an estimated \$0.11 per hundredweight in 1992 and \$0.06 per hundredweight in 1995. As a result, the increase in gross incomes of dairy producers was larger under this simulation than under simulation 3, but smaller than under simulations 1 and 2.

Generally, the impacts on dairy product removals, prices, production, and consumption were very similar to those estimated under simulation 3. Dairy program costs, however, declined much less under this simulation as reduced assessments offset much of the savings resulting from lower removals.

### SUMMARY

The prices of 1 and 2 percent milk would be most affected by nationwide adoption of the California nonfat solids standards. The retail price of regular (unfortified) 1 percent milk would increase by an estimated \$0.23 to \$0.28 per gallon and the retail price of regular 2 percent milk would increase by an estimated \$0.14 to \$0.19 per gallon. The retail prices of all types of fluid milk would average \$0.09 to \$0.13 per gallon higher. Nationwide adoption of the California standards was projected to raise consumer expenditures for dairy products by \$500 to \$900 million per year.

Consumption of nonfat solids was estimated to rise by 300-400 million pounds per year following

nationwide adoption of the California standards. Increased consumption of nonfat solids would lower CCC purchases of nonfat dry milk and raise nonfat dry milk prices. Butter purchases would rise while cheese purchases would fall as higher prices for nonfat dry milk increase the amount of milk used in butter/powder production and lower the amount of milk used in cheese production.

CCC outlays for the dairy program declined, on average, by about \$150 million per year under most scenarios. However, if CCC dairy product purchases greatly exceeded 7 billion pounds, program savings fell to about \$70 million annually. Budget savings declined if purchases greatly exceeded 7 billion pounds, because the higher nonfat solids standards lowered producer assessments to cover the cost of CCC purchases in excess of 7 billion pounds. If dairy product purchases fell below 3.5 billion pounds, CCC outlays could increase. Under this scenario, adoption of the California standards was projected to trigger at least two \$0.25 per hundred-weight increases in the support price for manufacturing milk. These higher support prices would raise milk prices causing farmers to expand milk production. The expansion in milk production, resulting from the increases in the support price for manufacturing milk, could lead to purchases of dairy products larger than under the baseline.

The mandated increase in the nonfat solids content of fluid milk would increase farm-level milk prices and could lower producer assessments to cover the cost of CCC purchases. The simulation results suggest that adoption of the California nonfat solids standards would increase farm milk prices in the short-run by \$0.11 to \$0.58 per hundredweight or by 1 to 5 percent per year. In the long run, milk prices could increase at the farm by 1 to 2 percent per year. Dairy farmers' cash receipts were projected to increase by \$200 to \$900 million per year in the short run and by \$300 to \$700 million in the long run.

Nationwide adoption of the California nonfat solids standards would have its least impact on farmers (and consumers) when CCC removals are large. When CCC removals are large, adoption of the California standards were estimated to lead to a 1 to 2 percent increase in farm milk prices in the short run. Thus, nationwide adoption of the California standards cannot be expected to counter sharp declines in milk prices, such as those that occurred during the last half of 1990.

## REFERENCES

- Gadson, Kenneth E., J. Michael Price, and Larry E. Salathe. *The Food and Agricultural Policy Simulator (FAPSIM): Structural Equations and Variable Definitions*. Washington, DC: USDA ERS, Staff Rpt. No. AGES820506, May 1982.
- Goold, J. "Minimum Component Standards Project for Fluid Milk." League of California Milk Producers, Sacramento, CA, 1982.
- Haidacher, Richard C., James R. Blaylock, and Lester Myers. *Consumer Demand for Dairy Products*. Washington, DC: USDA ERS Agr. Econ. Rpt. No. 586, Mar. 1988.
- Jacobson, R. E. "Case For and Against Higher SNF Standards for Fluid Products." Paper presented at the 50th Dairy and Food Industry Conference, Ohio State University, Feb. 16, 1983.
- Maes, L. A. "Minimum Standards and Component Pricing: The Handler's Viewpoint." Paper presented at the Western Dairy Conference, Scottsdale, AZ, Apr. 1984.
- Novakovic, Andrew, and Richard Aplin. *Some Findings on the Comparative Cost of Reconstituting Beverage Milk Products—Reconstitution vs. Fresh Milk Processing*. Dept. Agr. Econ, A.E. Res. 81-15, Cornell Univ., Aug. 1981.
- Salathe, Larry E., J. Michael Price, and Kenneth E. Gadson. "The Food and Agricultural Policy Simulator: The Dairy-Sector Submodel." *Agr. Econ. Res.* 34.3(1982):1-14.
- U.S. Department of Agriculture. "ASCS Commodity Fact Sheet: 1990-91 Dairy Price Support Program." Washington, DC: ASCS, July 1991.
- U.S. Department of Agriculture. *Nationwide Adoption of the California Solids Standards for Fluid Milk Products: Issues and Impacts*. Washington, D.C.: ERS, Staff Report No. AGES840816, Aug. 1984.
- U.S. House of Representatives. *Food, Agriculture, Conservation, and Trade Act of 1990*. Washington, D.C.: Report 101-916, U.S. GPO, 1990.
- U.S. House of Representatives. *Milk Inventory Management Act of 1991*. H.R. 2837, July, 1991.

