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by

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Introduction

From 1980 to 1985, total U.S. milk production increased 12 percent (15 billion pounds) despite a 3.3 percent decline in average farm price and a 14 percent decline in returns less cash and replacement costs (Betts). In real terms, net returns were down one-third in 1985 relative to 1980.

Three factors are commonly cited for the increased milk production at lower prices. First, productivity gains were a major contributor to the supply shift. However, substantial productivity gains have characterized the dairy industry for several decades and are not unique to the eighties. Second, the dairy industry has experienced a clearly lower exit rate in the eighties relative to earlier times. Lack of attractive alternatives and the increased specialization of the typical dairy farm has decreased the resource mobility in the sector. Third, rapid development of the dairy industry in the lower cost Mountain and Pacific states has occurred in the eighties. When national exit rates are low, growth in any region of the dairy industry will boost U.S. milk production.

Emerging technologies will also impact the supply curve of the dairy sector in the near future. Biotechnology, in the form of bovine somatotrophin (BST), has the potential to substantially increase milk yields in the face of existing surplus milk producing capacity.

BST is expected to be available for commercial use by 1989 or the early 1990s (Fallert, Betts and Buxton). Daily injections of BST increase body metabolism and milk production by raising the blood flow through the mammary system. Research has found that, under controlled conditions, milk yields increase 10 to 40 percent within three days of initial injection when administered during the latter two thirds of a normal 305-day lactation (Bauman et al.). This 10 to 40 percent increase over the latter 215 days of lactation translates to an annual increase of 7 to 28 percent. While the commercial cost to dairy farmers is uncertain at this time, Kalter et al. found that BST use is profitable and that it will be rapidly adopted by dairy farmers. And although the ultimate effect of BST on variable costs of production is unclear (the need for more nutritionally rich rations versus reduced feed requirements per pound of milk), the increased production per animal will almost certainly reduce total cost per unit produced.

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Previous analyses have examined the effects of BST on the New York state dairy industry (Magrath and Tauer, 1986 a and b; Tauer, 1986). Their analyses incorporated a sector linear programming model. Yonkers, et al., used a representative farm approach to examine the impact of BST on the financial situation of dairy farms under alternative adoption scenarios. As expected, they found regional differences in farm survival rates both with and without BST.

This study examined the impact of BST on the U.S. dairy industry and differed from the regional or geographic orientation of previous analyses. In addition, the present study explicitly investigated the adjustment path of the dairy sector through 1992 and did not presume complete market adjustment during that time period. The impacts of BST were examined under alternative policy scenarios and different rates of production response. One rate was a 25 percent increase in productivity that approximates the maximum increase obtained to date on an experimental basis. Since field response will likely not be as great, a 15 percent rate was also considered.

Procedures

Using a modified version of the 36 equation econometric model of the U.S. dairy industry (Torufa) operationally maintained by the Food and Agricultural Policy Research Institute (FAPRI), University of Missouri-Columbia, five different scenarios were examined for effects on cow numbers, production per cow, total milk production, net government removals, government cost and the farm price of milk. The model includes behavioral equations at the farm, wholesale and retail levels. As a result, the impact of technological change on production can be assessed at all levels with price signal feedback an integral part of the process. Individual equations were estimated over the time period 1962-1984 via OLS. The solution values presented in this analysis were obtained by the simultaneous solution of the system of equations using the Gauss-Seidel iterative technique. Figure 1 depicts of the product flows and price-quantity interactions contained in the model.

The supply sector of the model consists of six structural equations and one identity. Structural equations are estimated for January 1 dairy cow numbers, average number of cows on farm, average number of replacement heifers on farm, dairy cow additions, 16 percent protein ration cost and milk production per cow. Total milk production is simply the product of production per cow and the average number of cows on farm in a given year. The supply elasticity with respect to the farm price of milk (evaluated at the mean) is about -.13 in this model.

Fourteen behavioral equations and 15 identities comprise the demand sector. Per capita consumption (net of donations) is estimated for each of six product categories: fluid milk, butter, cheese, non-fat dry, frozen and evaporated. A net returns formulation is used to estimate the proportion of manufacturing grade milk utilized by each of the five non-fluid categories. Retail price linkage equations are estimated for the

fluid, cheese, butter and frozen sectors. The aggregate retail demand elasticity (evaluated at the mean) is about -.40. Dairy exports, government and commercial stocks, removals, donations and military consumption are exogenous to the model.

The first scenario, or baseline, assumed no introduction and/or adoption of BST through 1992. The baseline also assumes continuation, through 1992, of the dairy program currently specified in the Food Security Act of 1985 (FSA85). With respect to this analysis, the most important provision of the FSA85 legislation is the link between government removals and support prices. A 50 cent reduction in milk support prices is prescribed for any year in which net government removals are expected to exceed 5 billion pounds. A 50 cent increase in the support price will occur for any year in which net government removals are expected to fall below 2.5 billion pounds.

For the second scenario, BST adoption is assumed to begin in 1989 and continue through 1992. This study uses the diffusion process outline by Kalter et al. which suggests the following adoption rates:

1 year	5.4 percent of farms;
2 years	15.3 percent of farms;
3 years	39.7 percent of farms;
4 years	79.0 percent of farms.

The fourth year approximates a ceiling adoption rate and corresponds to 1992 in this analysis. The study by Kalter et al. also reported that early and middle adopters had statistically larger herd sizes than late adopters. Since the current study assumes, for convenience, equiproportionality of production and number of farms, the results obtained may underestimate the impact implied by Kalter et al. BST is assumed to increase milk yields by 15 percent over baseline levels in the second scenario.

The third scenario assumes the elimination of government involvement with the dairy sector upon the commercial introduction of BST in 1989. Again, a 15 percent increase in milk yields over what would be expected without BST is utilized. The fourth and fifth scenarios are identical to the second and third scenarios, respectively, with one exception; milk yields were assumed to increase by 25 percent relative to the yields anticipated without BST.

Results

Milk production is projected to increase 3.6 percent from 1986 to 1992 under the baseline assumptions of this analysis (Table 1). Once the Dairy Termination Program is completed in 1987, production will increase 2.0 percent in 1988 and 1.1 percent in 1989 before falling 1.2 percent in 1990. Despite the 50 cent decline in support prices anticipated in 1988 and 1989, declines in feed costs in these years will allow milk producers to realize rates of return similar to or better than those received in 1985 and 1986. However, FAPRI/Wharton's forecasted 10 percent increase in feed costs in 1990, combined with another

50 cent reduction in support prices for the year, curtails production as concentrate feedings decline and production per cow falls 0.4 percent. The good news for dairy farmers is that the nearly 2 billion pound decline in milk production in 1990 allows government removals to fall below 5 billion pounds, thereby halting the perennial 50 cent decline in support prices. Production is expected to increase 2.5 percent from 1990 to 1992 with removals and government costs remaining low.

Under FSA85 with BST increasing milk yields by 15 percent beginning in 1989, total production is expected to rise 10 percent over the forecast period relative to the baseline (Table 2, Scenario 2). With the greater production levels due to BST, government removals never fall below 5 billion pounds. Both the support and farm prices continue their downward slide in 1991 and 1992 and contribute to the less than 15 percent increase in production per cow relative to the baseline.

Government removals and, hence, costs are much higher under the 15 percent BST scenario than under the baseline. By 1992, both removals and government costs are over three times larger than under the baseline, reaching over 14 billion pounds and over $2.5 billion respectively.

The third scenario assumes the dismantling of the U.S. dairy program upon the introduction of BST for commercial purposes in 1989 (Table 2, Scenario 3). Although production falls 1.2 percent in 1989 relative to the baseline, farm price falls over 13 percent to $9.65/cwt. A small decline in production in 1990 boosts prices to $10.50/cwt. before a small production increase in 1991 and a 5.3 percent increase in 1992 drives farm prices to variable cost levels in 1992. Although 1989 milk production per cow actually falls relative to the baseline, it is 6 percent higher than the baseline by 1992. Total milk production is only 3.7 percent higher in 1992 as herd size is reduced more quickly than in the baseline.

The fourth scenario is identical to the second scenario except for the assumed 25 percent increase in production per cow from BST. The 25 percent scenario outlines the impacts which could be expected if the optimal results obtained in experimental situations can be reproduced under more normal conditions. While the price path remains the same as in the 15 percent scenario, total production is 7.6 percent higher in 1992 and both net removals and government costs are 87 percent higher in that year (Table 3). Milk production per cow is 7.8 percent higher in 1992 relative to the 15 percent scenario and 19 percent higher than baseline. Cow numbers drop only slightly compared to the 15 percent scenario.

The fifth scenario assumes termination of the dairy program coinciding with the commercial introduction of BST in 1989 and a 25 percent increase in milk yields. As expected, price drops are more pronounced under this scenario. The decline in farm price to variable costs of production occurs in 1991 rather than 1992. However, Kalter's diffusion rate implies that farm price will approximate variable costs after only 40 percent of farms have adopted BST. The market will simply not bear much additional production beyond that point. As a result, there is a greater

reduction in cow numbers in 1992 than in the 15 percent scenario and production increases only 1.2 percent over 1991 levels. The consequences of market saturation before full diffusion could weigh heavily on less than average size dairy farms (Kalter et al.).

Implications and Conclusions

While the Dairy Termination Program and annual 50 cent reductions in milk price supports are expected to bring supply and demand into balance in the absence of BST, commercial introduction of BST beginning in 1989 will seriously alter the adjustment process currently at work in the dairy industry. Under the 15 percent BST and FSA85 scenario, total production increases nearly 14 percent from 1986 to 1992. Net government removals and government cost reach unprecedented levels. While a 15 percent increase in milk yields may be a more realistic assumption than the 25 percent rate examined, it should be recalled that production and government cost figures may be understated if larger firms adopt BST more rapidly than smaller ones. Further refinements in BST production and/or utilization could also increase the yield potential of the product.

The elasticity of demand is also a crucial consideration in an analysis of this nature. While the aggregate demand elasticity of the model used in this analysis is consistent with demand system estimates of about -0.40 (Barewal and Goddard, Brandt et al., Huang and Haidacher, Johnson and Safyurlu), aggregate demand elasticities in dairy product specific models tend to be about -0.25 (Heien, Torufa). A lower demand elasticity in the current analysis would mean higher removals and government costs in the FSA85/BST scenarios and lower prices in the early years of the free market/BST scenarios.

Finally, the analysis suggests that the resource commitment to dairying will likely experience continued pressure in the near future. Failure to relax price supports would become increasingly costly at a time when the financial commitment to agriculture is increasingly tenuous. Elimination of price supports would result in an adjustment process extending beyond 1992. Whatever the outcome with respect to government programs, the future profile of the dairy industry will be substantially different from the current situation.

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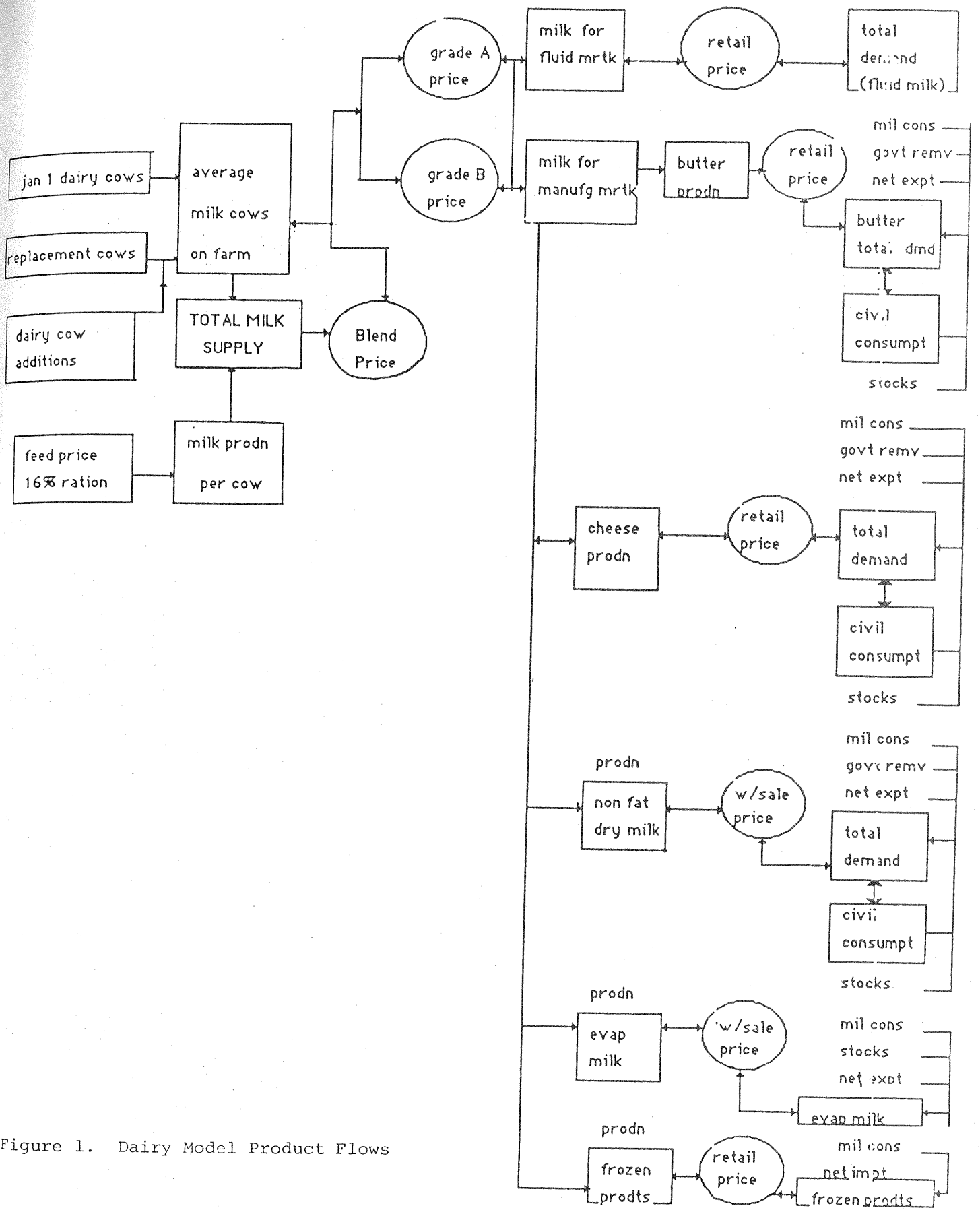

Figure 1. Dairy Model Product Flows

TABLE 1

Scenario 1 : Baseline*

	1986	1987	1988	1989	1990	1991	1992
PRODUCTION PER COW (THOU LBS)	13.29	13.67	13.95	14.21	14.15	14.47	14.67
MILK COWS (MIL)	10.84	10.46	10.46	10.38	10.29	10.22	10.18
TOTAL PROD (BIL LBS)	144.08	143.00	145.85	147.44	145.67	147.83	149.24
FARM PRICE ($/CWT.)	12.48	12.35	11.62	11.10	10.60	10.60	10.60
REMOVALS (BIL LBS)	10.63	7.69	7.47	7.23	4.59	4.75	4.38
GOVT COST (BIL $)	1.84	1.33	1.30	1.25	0.80	0.82	0.76

* Assumes continuation of dairy policy as specified in the Food Security Act of 1985 (FSA85) and and no introduction or adoption of BST.

TABLE 2

Scenario 2 : 15% BST with Price Supports*

	1986	1987	1988	1989	1990	1991	1992
PRODUCTION PER COW (THOU LBS)	13.29	13.67	13.95	14.33	14.48	15.24	16.19
MILK COWS (MIL)	10.84	10.46	10.46	10.38	10.29	10.19	10.12
TOTAL PROD (BIL LBS)	144.08	143.00	145.85	148.63	149.05	155.34	163.80
FARM PRICE ($/CWT.)	12.48	12.35	11.62	11.10	10.60	10.10	9.60
REMOVALS (BIL LBS)	10.63	7.69	7.47	8.42	7.97	7.54	14.16
GOVT. COST (BIL $)	1.84	1.33	1.30	1.46	1.38	1.31	2.46

* Assumes continuation of dairy policy as specified in the Food Security Act of 1985 (FSA85) and 15 percent BST adoption beginning in 1989.

Scenario 3 : 15% BST without Price Supports*

	1986	1987	1988	1989	1990	1991	1992
PRODUCTION PER COW (THOU LBS)	13.29	13.67	13.95	14.06	14.18	14.52	15.54
MILK COWS (MIL)	10.84	10.46	10.46	10.37	10.23	10.11	9.96
TOTAL PROD (BIL LBS)	144.08	143.00	145.85	145.74	145.09	146.90	154.75
FARM PRICE ($/CWT.)	12.48	12.35	11.62	9.65	10.50	8.28	7.53
REMOVALS (BIL LBS)	10.63	7.69	7.47	0.00	0.00	0.00	0.00
GOVT COSTS (BIL $)	1.84	1.33	1.30	0.00	0.00	0.00	0.00

* Assumes elimination of federal dairy program coinciding with 15 percent BST adoption beginning in 1989.

TABLE 3

Scenario 4: 25% BST with Price Supports*

	1986	1987	1988	1989	1990	1991	1992
PRODUCTION PER COW (THOU LBS)	13.29	13.67	13.95	14.40	14.70	15.84	17.45
MILK COWS (MIL)	10.84	10.46	10.46	10.38	10.29	10.17	10.10
TOTAL PROD (BIL LBS)	144.08	143.00	145.85	149.43	151.31	161.14	176.23
FARM PRICE ($/CWT.)	12.48	12.35	11.62	11.10	10.60	10.10	9.60
REMOVALS (BIL LBS)	10.63	7.69	7.47	9.22	10.23	13.34	26.59
GOVT.COSTS (BIL $)	1.84	1.33	1.30	1.60	1.77	2.31	4.61

* Assumes continuation of dairy policy as specified in the Food Security Act of 1985 (FSA85) and 25 percent BST adoption beginning in 1989.

Scenario 5: 25% BST without Price Supports*

	1986	1987	1988	1989	1990	1991	1992
PRODUCTION PER COW (THOU LBS)	13.29	13.67	13.95	14.18	14.41	15.20	15.72
MILK COWS (MIL)	10.84	10.46	10.46	10.33	10.22	10.07	9.86
TOTAL PROD (BIL LBS)	144.08	143.00	145.85	146.52	147.29	153.04	154.94
FARM PRICE ($/CWT)	12.48	12.35	11.62	9.50	10.05	7.40	7.50
REMOVALS (BIL LBS)	10.63	7.69	7.47	0.00	0.00	0.00	0.00
GOVT COSTS (BIL $)	1.84	1.33	1.30	0.00	0.00	0.00	0.00

[a] Assumes elination of federal dairy program coinciding with 25 percent BST adoption beginning in 1989