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A QUARTERLY MODEL OF THE U S DAIRY SECTOR AND SOME OF ITS POLICY
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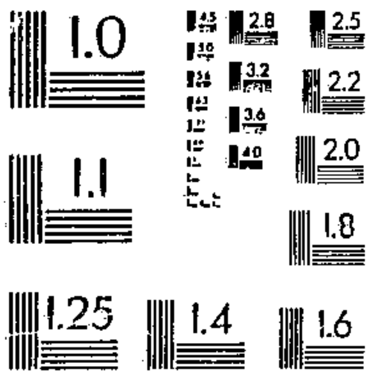

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A Quarterly Model of the U.S. Dairy Sector and Some of Its Policy Implications

Paul C. Westcott

A Quarterly Model of the U.S. Dairy Sector and Some of Its Policy Implications. By Paul C. Westcott. National Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin No. 1717.

Abstract

A quarterly econometric model of the U.S. dairy sector has been developed for use in short- to medium-term outlook and policy analyses. Simulations of the model indicate that it performs quite well both during the estimation period and during an eight-quarter interval beyond the estimation period. The model is used to estimate the effects of the recent 15-month paid diversion program and to examine some implications of three price support policy alternatives. Dynamic system multipliers are derived for personal disposable income, feed prices, cattle prices, and milk prices.

Keywords: Dairy, econometric model, forecasts, price supports, diversion program, model validation, multipliers

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Contents

Summary

This report presents a quarterly econometric model of the U.S. dairy sector, developed for use in short- to medium-term outlook and policy analyses. Simulations of this dairy sector model indicate that it performs quite well both during the estimation period and during an eight-quarter interval beyond the estimation period.

The dairy sector model is added to a previously developed model covering six other agricultural commodities: corn, wheat, soybeans, cattle, hogs, and poultry. The overall quarterly agriculture forecasting model consists of approximately 130 equations.

Properties of the dairy sector model are investigated by looking at adjustments to changes in selected variables. Dynamic system multipliers are derived for personal disposable income, feed prices, cattle prices, and milk prices.

Two policy issues are examined using the aggregate dairy sector model. First, the model is used to estimate the effects of the 15-month paid diversion program. Results suggest that a temporary diversion program only partially and temporarily addresses the dairy supply/demand imbalance problem.

Second, the model is used to examine some implications of three price support policy alternatives, ranging from leaving the price support at its 1984 level of \$12.60 per cwt to lowering the price support to \$10 per cwt. Results suggest that the price support can be an effective policy tool to address the supply/demand imbalance in the dairy sector, but if price supports are not reduced substantially, net Government removals of dairy products would probably remain large through the end of the decade. An adjustable dairy support price mechanism would help the supply/demand imbalance in the dairy sector while allowing for adjustments to changes in other factors affecting the dairy sector.

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Introduction

The Economic Research Service (ERS) has developed a quarterly forecasting model of the U.S. agricultural sector to aid in its situation and outlook program and related activities. The model is designed for use as an analytical tool in short- to medium-term outlook and policy analysis. Six subsectors were included in the initial quarterly agriculture forecasting model, covering corn, wheat, soybeans, cattle, hogs, and poultry (*15*).[1] This report discusses a quarterly aggregate model for the U.S. dairy sector and examines some of its policy implications. With the addition of the dairy sector, the overall quarterly agriculture forecasting model consists of approximately 130 equations, about half behavioral and half identities.

Historical Background

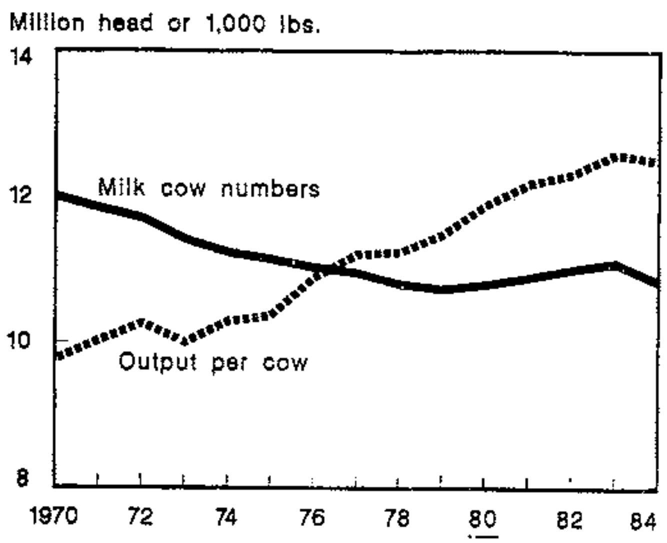
Milk cow numbers declined through most of the 1970s (fig. 1). Dairy provisions in the Food and Agriculture Act of 1977, however, encouraged expansion, and milk cow numbers began rising. Milk cow numbers fell somewhat in 1984 due to the paid diversion program, although milk cow numbers began to rise again following the end of that program.

Production per cow has continued upward over the last 15 years. Two major factors underlying this trend include the genetic improvement of the dairy herd and improved dairy secto management practices. Increasing productivity of milk cows is likely to continue with emerging technologies such as isoacid nutritional supplements and bovine growth hormones. Additional farm computer applications will further improve management. This upward trend in dairy herd productivity is a major industry characteristic to consider in forming dairy sector policy.

As a result of the trends in cow numbers and output per cow, milk production has trended upward since the mid-1970s (fig. 2). Commercial use has also risen over the last 15 years but more slowly than production, widening the gap between supply and demand.

This is where the Government steps in. The Government sets the price support level and the Commodity Credit Corporation (CCC) purchases (removes) dairy

Figure 1
Milk cow numbers and output per cow



[1] Italicized numbers in parentheses refer to items in the references.

Figure 2
Milk production and commercial use

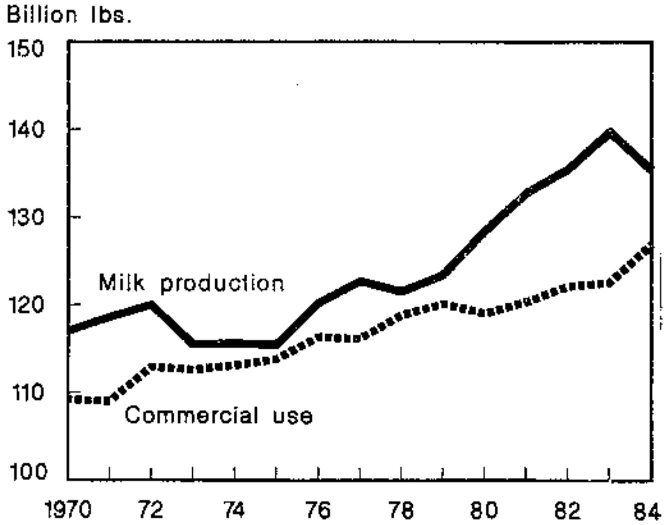
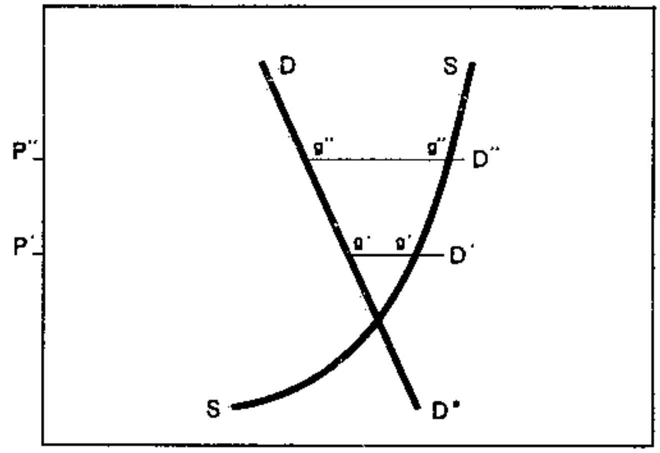


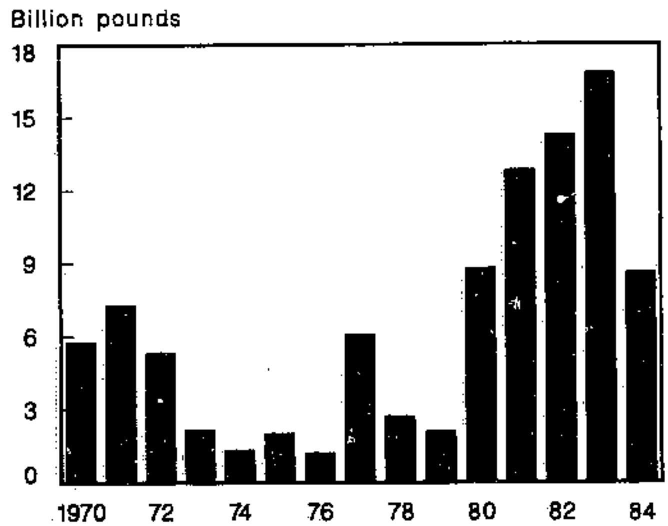
Figure 3
Aggregate dairy supply and demand, static framework



products from the market to maintain the producer price at a level high enough to ensure adequate milk supplies. This process is depicted in an aggregate representation of the dairy sector in a static framework (fig. 3). The supply function is represented by the SS curve. The DD* curve represents all nongovernmental demands for dairy products. When the intersection of these curves results in an equilibrium price below the price support level, the Government purchases dairy products to bring producer prices up to support. For example, with the price support set at P', the Government would remove from the marketplace an amount of dairy products equal to g'g' (fig. 3). This results in the effective demand curve, represented by DD'. With a higher price support of P'', for example, the Government would purchase a larger amount of product (represented in fig. 3 by g''g'') and the effective demand curve would be DD''.

After being relatively low in the mid-1970s due to the effects of high grain prices and energy costs on milk production, net Government removals (milk equivalent, milkfat basis) rose and have grown sharply in the first part of this decade (fig. 4). Net Government removals of dairy products reached nearly 17 billion pounds in 1983 and cost about $2.6 billion before declining in 1984 due to the dairy diversion program and a lower milk price-feed cost ratio *(2)*.

Figure 4
Net Government removals



The Model

The quarterly dairy sector model is a nine-equation aggregate model. All supply and demand variables in the model are aggregates over all dairy products, expressed on a milk equivalent, milkfat basis. Behavioral equations are estimated for four key categories—milk cow inventories, production per cow, commercial use, and farm-level milk prices. Equations for production, marketings, total supply, net Government removals, and effective milk prices are identities, with net Government removals being the market-clearing equation. Farm use of milk, imports, and commercial stocks are exogenous supply and use variables. The milk price deduction and milk price support are exogenous policy variables, allowing alternative policy assumptions to be simulated. Although this is an aggregate model, it covers the major supply, demand, and price categories of usual interest for short- to medium-term outlook and policy analyses.

Figure 5 represents the general model structure used for the dairy sector model. Table 1 presents the equations used in the model. The behavioral equations were estimated using ordinary least squares (OLS) regressions. For each behavioral equation, t-statistics are reported in parentheses below the parameter estimates. The coefficient of determination (R^2), the root mean squared error (RMSE), and the coefficient of variation (CV) are reported for each behavioral equation. The estimation period used is 1971-81. The variable definitions employed are shown in table 2.

Milk Cow Inventories

Milk cow inventories are the capital stock in the dairy sector. The major factors which affect cow inventories include expected returns, expected production costs, and opportunity costs. Shortrun adjustments are made through culling decisions, while the addition of replacement heifers to the milk cow inventory is longer run in nature due to biological constraints.

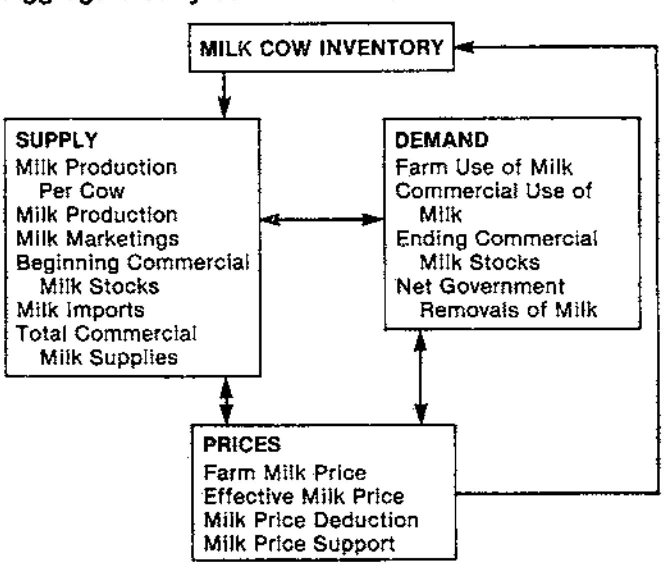
Instead of explicitly modeling the additions to and cullings of the milk cow inventory as in Reed *(8)*, the milk cow inventory equation in this study was estimated directly as a function of lagged milk cow inventories, the effective milk price, feed prices, cattle prices, and dummy variables for the first and second quarters of the calendar year.[2]

The coefficient on the lagged dependent variable is nearly 1, indicating the relative fixity of milk cow inventories in the short run. Nonetheless, it is significantly different from 1 at the 1-percent level due to normal death loss and culling. Lagged effective milk price represents expected returns and reflects the shortrun price incentive underlying producers' expansion/contraction decisions. Lagged feed prices are a weighted average of corn prices (83 percent) and soybean meal prices (17 percent) and represent production costs for the major dairy feeds. Cattle prices represent the profitability of competing beef enterprises as is done by Buxton in a study of determinants of annual milk production *(1)*. The coefficients of the dummy variables imply very small seasonality in milk cow inventories.

Another factor which can affect milk cow inventories is the general economic condition. Buxton suggests representing general economic conditions by the unemployment rate *(1)*. Attempts were made in this current study to incorporate this into the quarterly inventory equation. Although a reasonably good equation estimate resulted, it did not prove superior to the inventory equation used in the current model (table 1) for the short- to medium-term forecasting and policy applications of interest in this study. Because this alternative equation estimate may be of interest for other applications, it is shown in Appendix A, along with a second alternative milk cow inventory equation. This latter equation was used in earlier versions of the aggregate dairy sector model [see *(14)*, for example] and

Figure 5

Aggregate dairy sector model structure



[2]The milk cow inventory equation was estimated with no intercept because of high collinearity in the equation with the intercept included. The reported R^2 was then derived by squaring the simple correlation between the actual data and the estimated equation's predicted series.

Table 1—Quarterly aggregate dairy sector model

Milk cow inventory

$$COWKM = \underset{\substack{(836.25)\\(5.44)^{1}}}{0.994}\ COWKM_{t-1} + \underset{(5.40)}{16.70}\ MIPEFF_{t-1} - \underset{(2.01)}{8.76}\ FDPFM_{t-1} - \underset{(2.70)}{1.19}\ CAPFM - \underset{(3.12)}{25.63}\ D1 - \underset{(3.85)}{30.84}\ D2$$

$R^2 = 0.997$ RMSE = 21.46 CV = 0.19

Milk production per cow

$$MISPRPC = 1021.51 + \underset{(3.80)}{0.496}\ MISPRPC_{t-4} + \underset{(1.84)}{22.44}\ MIPEFF_{t-1} - \underset{(3.20)}{0.385}\ SMPDM_{t-1} + \underset{(1.15)}{15.35}\ GI + \underset{(1.71)}{28.95}\ D1 + \underset{(3.50)}{174.05}\ D2 + \underset{(3.41)}{78.63}\ D3 - \underset{(3.44)}{68.26}\ D75$$

$R^2 = 0.982$ RMSE = 33.98 CV = 1.25

Milk production

$$MISPR = (COWKM \cdot MISPRPC)/1000$$

Milk marketings

$$MISMRK = MISPR - MIUFR$$

Total supply of milk

$$MISST = MISMRK + MICITC + MISMT$$

Commercial milk use

$$MIUCM = 19534.40 - \underset{(1.11)}{26769.07}\ (MIPFM/CPI) + \underset{(6.55)}{1386.80}\ (Y/CPI) + \underset{(5.11)}{103.45}\ D2 \cdot TA + \underset{(8.17)}{164.60}\ D3 \cdot TA + \underset{(5.79)}{112.59}\ D4 \cdot TA$$

$R^2 = 0.852$ RMSE = 513.92 CV = 1.78

Net Government removals of milk

$$MICGVN = MISST - MIUCM - MICOTC$$

Continued—

Table 1—Quarterly aggregate dairy sector model—continued

Farm milk price

$$MIPFM = 3.89 + (\underset{(27.90)}{1.01}\ D1 + \underset{(18.48)}{0.990}\ D2 + \underset{(18.50)}{0.921}\ D3 + \underset{(23.46)}{0.938}\ D4)\ MIPSP - \underset{(4.92)}{0.312}\ (MISPR/1000) + \underset{(2.43)}{0.246}\ (MIUCM/1000)$$

$R^2 = 0.980$ RMSE = 0.39 CV = 4.13

Effective milk price

$$MIPEFF = MIPFM - MIPDED$$

Note: The t-statistic is reported in parentheses below each coefficient. RMSE is the root mean squared error. CV is the coefficient of variation. The estimation period for each behavioral equation is 1971-81.

[1]Number reported is the t-statistic for the test of the coefficient different from 1.

Table 2—Quarterly aggregate dairy sector model variable definitions

Variables	Definition	Units
CAPFM	Beef cattle price, farm	\$/cwt
COWKM	Milk cow inventory	Thousand head
CPI	Consumer price index	1967 = 100
Di	Dummy variable equal to 1 in the i-th quarter, i = 1, 2, 3, 4	N.A.
D75	Dummy variable equal to 1 in 1975	N.A.
FDPFM	Feed price[1]	\$/cwt
GI	Genetic improvement proxy–annual trend equal to 1 in 1966	N.A.
MICGVN	Net Government removals of milk	Mil. lbs.[2]
MICITC	Beginning commercial milk stocks	Mil. lbs.
MICOTC	Ending commercial milk stocks	Mil. lbs.
MIPDED	Milk price deduction	\$/cwt
MIPEFF	Effective milk price	\$/cwt
MIPFM	Milk price, farm	\$/cwt
MIPSP	Support price for milk	\$/cwt
MISMRK	Milk marketings	Mil. lbs.
MISMT	Milk imports	Mil. lbs.[2]
MISPR	Milk production	Mil. lbs.
MISPRPC	Milk production per cow	Pounds
MISST	Total commercial milk supplies	Mil. lbs.
MIUCM	Commercial disappearance of milk	Mil. lbs.[2]
MIUFR	Farm use of milk	Mil. lbs.
SMPDM	Soybean meal price, Decatur, 44-percent protein	\$/ton
TA	Annual trend equal to 1 in 1966	N.A.
Y	Personal disposable income, nominal	Bil. dol.

N.A. = Not applicable.
[1]Weighted average of corn price and soybean meal price.
[2]Milk equivalent of products, milkfat basis.

has slightly better single-equation properties than the inventory equation shown in table 1. However, the inventory equation used in the current version of the model was chosen due to structural concerns.

Milk Production Per Cow

Besides the culling decision discussed earlier, producers can also adjust milk production in the short run by influencing production per cow. This is largely accomplished by adjusting rations fed to dairy cows in response to expected returns and costs. Increasing productivity of the dairy herd–an important long-term dairy sector characteristic–is also reflected in production per cow data. Further, production per cow exhibits seasonality that reflects seasonal patterns in milk cow freshenings and weather-related animal stress.

The equation for production per cow follows a specification used by Reed *(8)*. Expected returns are represented by a one-quarter lag of effective milk prices. Production costs are represented by a one-quarter lag of prices of soybean meal, a major protein source used in dairy rations. Productivity gains in production per cow are represented by the genetic improvement variable, an annual trend. Its coefficient implies a production increase of about 61 pounds per cow each year (due to genetic advancements) and represents about 0.6 percent of the average production per cow over the estimation period. The seasonality of production per cow is represented by the three quarterly dummy variables and the fourth-order autoregressive term.

Milk Production, Marketings, and Supplies

Three identities complete the supply side of the aggregate dairy model. Milk production is obtained by multiplying the cow inventory by production per cow. Marketings are equal to production minus onfarm milk use. Total milk supplies are equal to marketings, beginning commercial dairy product stocks, and dairy product imports, all expressed on a milk-equivalent, milkfat basis.

Commercial Milk Use

Commercial use of milk is the major demand for milk and is a factor demand equation in this model. As such, commercial milk use would be related to the factor cost and retail product price. Collinearity between farm-level milk prices and retail dairy product prices preclude a specification with both included. Thus, commercial milk use in the model is a function of the deflated milk price to represent factor costs and deflated income to represent final product demand. Interaction terms between quarterly dummy variables and an annual trend reflect growth and seasonality in commercial milk use. In particular, the largest coefficient is for the summer quarter when wholesale demand for dairy products is largest, while the omitted winter quarter is when demand is lowest.

Net Government Removals of Milk

Net Government removals of milk represent the role of the Government in the dairy sector. The Commodity Credit Corporation purchases and removes dairy products from the marketplace as part of the support price program. This equation serves as the market-clearing equation in the model and sets net Government removals of milk equal to total milk supplies less commercial milk use and commercial ending stocks.

Farm-Level Milk Price

The role of the Government, particularly the price support, is also important in determining milk prices. Accordingly, the farm-level milk price equation is a function of the support price with slope shifters allowing for seasonality. Aggregate production and commercial milk use represent supplies and non-Governmental demand factors.

Effective Milk Price

The effective milk price differs from the farm-level milk price by the level of the milk price deduction that producers are assessed. As such, it is the effective price that producers receive and is used for the supply equations in the model.

Model Validation

Simulations were performed and validation statistics were generated over the within-sample period and an eight-quarter beyond-sample period in order to evaluate the model. The simulations were designed to test the model on the basis of its intended application as a three- to six-quarter ahead forecasting tool for use in short- to medium-term outlook and policy analyses. Accordingly, separate dynamic model simulations were performed for each within-sample year 1971-81, giving 44 model predictions for each endogenous variable. Two beyond-sample simulations were also performed over the eight quarters of 1982 and 1983. Actual exogenous data were used throughout all simulations. Validation statistics based on these dynamic simulations of the model form the basis of a quantitative evaluation (table 3).

Table 3 shows summary validation statistics for each dependent variable. Relative mean absolute errors (RMAE), Theil inequality statistics, and the relative number of turning point errors (RTPE) are presented. RMAE equals the mean absolute error (MAE) expressed as a percentage of the mean of the dependent variable ($\bar{y}$). That is, RMAE = (MAE/$\bar{y}$)100. The Theil inequality statistic equals $[\Sigma[(p_t-a_{t-4})-(a_t-a_{t-4})]^2/\Sigma(a_t-a_{t-4})^2]^{0.5}$, where p_t and a_t are the predicted and actual values of variables in time period t and summations are taken over all simulation periods. When $t \leq 4$, pre-simulation values of the endogenous variables are used for a_{t-4}. A Theil inequality statistic less than 1 implies superior simulation performance relative to a naive forecast of no change from four quarters earlier.

The RTPEs are the number of turning point errors expressed as a percentage of the total number of simulation observations. A turning point error occurs when $(p_t-a_{t-4})(a_t-a_{t-4}) < 0$. As with the Theil inequality statistics, pre-simulation values of endogenous variables are used for a_{t-4} when $t \leq 4$.

These three summary statistics were chosen because they represent three properties desired of forecasting models–a measure of the simulation errors, a comparison of the econometric model with an appropriate naive model (here, the simple model of no change from four quarters earlier), and a measure of how well turning points are "caught."

Both the Theil inequality statistic and the turning point error analysis use the term (p_t-a_{t-4}) which is the change between the current predicted level and the actual level four quarters ago. Levels from four quarters earlier were used instead of levels from one quarter earlier because of the seasonality evident in most agricultural variables. Also, actual levels from four quarters earlier were used rather than predicted levels because the model is designed to be a short- to medium-term outlook and policy model where, in most applications, four-quarter earlier levels are known. This is consistent

Table 3—Aggregate dairy sector model validation statistics for within-sample and beyond-sample simulations[1]

Quarterly dependent dairy variables	Relative mean absolute error[2]		Theil inequality statistic[3]		Relative turning point errors[4]	
	Within sample	Beyond sample	Within sample	Beyond sample	Within sample	Beyond sample
	—Percent—		—Number—		—Percent—	
Milk cow inventory	0.3	0.1	0.30	0.17	0	0
Milk production per cow	.9	.9	.40	.61	7	13
Milk production	1.0	.9	.46	.45	16	0
Milk marketings	1.1	.9	.45	.45	18	0
Total commercial milk supplies	.9	.8	.25	.47	18	25
Commercial disappearance of milk	1.2	1.0	.55	.84	16	25
Net Government removals of milk	38.0	13.6	.48	1.13	16	38
Farm milk price	3.0	1.7	.39	1.96	11	13
Effective milk price	3.0	1.8	.39	.57	11	0

[1]Based on dynamic simulations of the aggregate dairy sector model with regard to the endogenous variables, using actual exogenous data throughout. Within sample simulations: 1971-81; beyond sample simulations: 1982-83.

[2]RMAE equals 100 times the mean absolute error relative to the mean of the dependent variable—(MAE/$\bar{y}$)100.

[3]The Theil inequality statistic equals $[\Sigma [(p_t-a_{t-4})-(a_t-a_{t-4})]^2/\Sigma (a_t-a_{t-4})^2]^{0.5}$, where p_t and a_t are the predicted and actual values of variables in time period t and summations are taken over all simulation periods. When $t \leq 4$, pre-simulation values of the endogenous variables are used for a_{t-4}. A Theil inequality statistic less than 1 implies superior simulation performance relative to a naive forecast of no change from four quarters earlier.

[4]RTPE equals 100 times the number of turning point errors divided by the total number of simulation observations. A turning point error occurs when $(p_t-a_{t-4})(a_t-a_{t-4}) < 0$. As for the Theil inequality statistics, pre-simulation values of endogenous variables are used for a_{t-4} when $t \leq 4$.

with Theil's definition of the inequality statistic *(10,* pp. 28 and 48) where Theil implicitly defines the predicted change as $p_t - a^*_{t-4}$ where a^*_{t-4} is the level of a_{t-4} known at the time the forecast is made. Since we are forecasting four quarters ahead with this model, a_{t-4} will always be known and hence a^*_{t-4} equals a_{t-4}.

The within-sample validation statistics demonstrate that the model performance was very good. With the exception of net Government removals, the RMAEs are all very low. All Theil inequality statistics are well below 1 and no RTPE exceeds 20 percent.

The relatively large RMAE for net Government removals results primarily from its predicted values being derived as residuals in the market clearing equation of the model. Estimates of net Government removals may consequently include simulation errors from all other endogenous supply and demand categories. Further, because the net Government removals variable is small relative to the two other endogenous variables (milk supplies and commercial milk demand) used in its derivation, relatively small simulation errors in the latter categories can result in relatively large RMAEs for net Government removals.

To illustrate, the low within-sample RMAEs for milk supplies and commercial milk demand correspond to mean absolute errors of 315 and 356 million pounds, respectively. Although these errors partly offset each other in the derivation of net Government removals estimates, the resulting mean absolute error of 449 million pounds represents more than one-third the average level of removals in the estimation period. That is, the RMAE for the model's residually derived net Government removals category is relatively large even though the RMAEs for milk supplies and commercial milk use are very low. This often happens when a data series is derived as the difference between two large categories, and is a characteristic not only of econometric models but of historical data series as well, such as net farm income as discussed in Lucier *(5).*

The beyond-sample validation statistics, covering the 1982 and 1983 simulations, indicate good model performance. The RMAEs for all dependent variables are less than or equal to the respective within-sample RMAEs. Two beyond-sample Theil inequality statistics exceed 1, although the farm-level price estimates have a low beyond-sample RMAE and only one turning point error. Three categories have RTPEs of 25 percent or more in the beyond-sample simulations. Two of these categories, however, have low corresponding RMAEs and Theil inequality statistics.

The beyond-sample simulation results for the model's residually-derived net Government removals category are less satisfactory. Its Theil inequality statistic exceeds 1 and turning point errors occur in three of the eight beyond-sample simulation periods. However, although the RMAE for net Government removals is again the largest, it is about one-third as large as in the within-sample period and corresponds to a mean absolute error of 530 million pounds, only slightly greater than attained in the within-sample simulations.

Dynamic Model Properties

Dynamic properties of the model were examined to investigate further the implications of the equations presented in table 1. Because the model is nonlinear, this was done by comparing results from a series of fully dynamic simulations of the model. First, a base simulation of the model was performed for 1979-85. Alternative scenarios were then simulated with selected variables changed. Comparing results of the alternative scenarios with the base solution illustrates the model's dynamic properties in adjusting to each change. Actual exogenous data were used in all simulations except as changed in the alternative scenarios or as forecasted for some quarters of 1985.

The alternative assumptions began in 1980, allowing the model to be simulated identically for four quarters in each simulation. The alternative scenarios were performed in a number of different ways. First, the variable to be changed was impacted in one quarter (1980-1), 1 year (all quarters of 1980), or throughout the remainder of the simulation interval (1980-85). This provides estimates of the model response to short-, medium-, and long-term changes. Second, the adjustments made to the impacted variable were done two ways--percentage changes and absolute changes. The former allows the derivation of unitless relative multipliers which measure fully dynamic percentage adjustments in dairy sector variables resulting from a 1-percent change in some particular variable. The latter allows the derivation of absolute multipliers for outlook and policy applications. Results are presented in terms of both absolute and relative impacts.

The variables of most interest in the aggregate dairy model for deriving multipliers are personal disposable income, feed prices, cattle prices, and milk prices. To put the multipliers presented in this section into perspective, table 4 indicates the magnitudes of recent quarter-to-quarter and year-to-year changes in these variables. The table shows the mean absolute and mean percentage changes from one quarter earlier and four quarters earlier for 1980 through 1984 for personal disposable income, feed prices, cattle prices, and milk prices.

Income Multipliers

Absolute and relative changes from the base scenario solution are shown for milk production, commercial milk disappearance, and milk price from the first quarter of 1980 through the end of 1985 resulting from short-, medium-, and long-term 1-percent increases in personal disposable income (tables 5-7).

In the short-term income impact scenario, personal disposable income is increased 1 percent from its base scenario level in the first quarter of 1980 and then returns to the base scenario levels afterwards (table 5). Commercial use rises 101 million pounds (0.35 per-

Table 4—Mean changes in selected variables, 1980-84

Variable	Mean change from			
	1 quarter earlier		4 quarters earlier	
	Absolute	Relative	Absolute	Relative
	$ bil.	*Pct.*	*$ bil.*	*Pct.*
Personal disposable income	46.5	2.2	185.3	9.3
	$/cwt		*$/cwt*	
Feed prices	.43	7.7	.98	17.7
Cattle prices	3.05	5.3	2.74	4.4
Milk prices	.33	2.5	.44	3.5

Table 5—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term 1-percent rise in personal disposable income[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	101.05	0.355	0.025	0.194
1980-2	7.3	0.021	.24	.001	−.002	−.017
1980-3	.6	.002	.02	—	—	−.001
1980-4	1.0	.003	.03	—	—	−.002
1981-1	1.0	.003	.03	—	—	−.002
1981-2	4.1	.012	.12	—	−.001	−.009
1981-3	.4	.001	.01	—	—	−.001
1981-4	.9	.003	.03	—	—	−.002
1982-1	.9	.003	.02	—	—	−.002
1982-2	2.4	.007	.07	—	−.001	−.006
1982-3	.5	.001	.01	—	—	−.001
1982-4	.8	.003	.02	—	—	−.002
1983-1	.8	.002	.02	—	—	−.002
1983-2	1.6	.004	.04	—	—	−.004
1983-3	.5	.001	.01	—	—	−.001
1983-4	.7	.002	.02	—	—	−.002
1984-1	.7	.002	.02	—	—	−.002
1984-2	1.1	.003	.03	—	—	−.003
1984-3	.5	.002	.01	—	—	−.001
1984-4	.7	.002	.02	—	—	−.002
1985-1	.6	.002	.02	—	—	−.001
1985-2	.9	.002	.02	—	—	−.002
1985-3	.5	.002	.01	—	—	−.001
1985-4	.6	.002	.02	—	—	−.002

— = Number is less than 0.0005 in absolute value.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases personal disposable income by 1 percent from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter.

cent) in the impact quarter but is essentially unchanged from the base scenario thereafter. Larger demand pushes prices up in the impact quarter by 2.5 cents per hundredweight (cwt) (0.19 percent). In response to the initially higher prices, milk production rises 7 million pounds (0.02 percent) the following quarter, but then falls to near the base levels. The production impacts during second quarters of subsequent years converge to the base levels more slowly than do production impacts in other quarters, mainly reflecting the fourth order autoregressive term in the production per cow equation.

For a medium-term 1-percent rise in personal disposable income, income is increased from its base scenario levels during each of the four quarters of 1980 and then returns to the base scenario levels afterwards (table 6). Similar to the short-term income impacts, commercial use rises by about 100 million pounds during each impact quarter, implying a unitless relative multiplier of about 0.34 percent for the first year. Stronger demand pushes prices up 2 to 2.5 cents during the first year. The partly offsetting effects of production adjustments pull the unitless relative multipliers down from 0.19 percent in the first impact quarter to 0.16 percent in the fourth impact quarter. Production impacts—responding to the initially higher prices—again start with a one-quarter lag, building to about 10 million pounds (0.03 percent), and then converging gradually toward the base scenario levels.

For the long-term income impact scenario, personal disposable income is increased permanently by 1 percent from its base scenario levels starting in the first quarter of 1980 (table 7). Commercial use rises over the simulation period in a relatively stable proportion of the income increase, with unitless relative multipliers of 0.32 to 0.38 percent. Prices stabilize at about 2 cents per cwt above the base scenario levels, with unitless relative multipliers between 0.14 and 0.19 per-

Table 6—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term 1-percent rise in personal disposable income[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	101.05	0.355	0.025	0.194
1980-2	7.3	0.021	98.90	.332	.022	.172
1980-3	7.7	.024	100.20	.324	.022	.173
1980-4	8.6	.028	100.97	.336	.022	.157
1981-1	9.8	.031	.30	.001	−.003	−.021
1981-2	7.0	.020	.21	.001	−.002	−.016
1981-3	6.4	.019	.19	.001	−.002	−.015
1981-4	6.2	.020	.18	.001	−.002	−.013
1982-1	6.2	.019	.18	.001	−.002	−.014
1982-2	4.9	.014	.14	—	−.002	−.011
1982-3	4.6	.014	.13	—	−.001	−.011
1982-4	4.4	.013	.12	—	−.001	−.010
1983-1	4.4	.013	.12	—	−.001	−.010
1983-2	3.9	.011	.11	—	−.001	−.009
1983-3	3.6	.010	.10	—	−.001	−.008
1983-4	3.4	.010	.09	—	−.001	−.008
1984-1	3.4	.010	.09	—	−.001	−.008
1984-2	3.3	.009	.09	—	−.001	−.008
1984-3	3.0	.009	.08	—	−.001	−.007
1984-4	2.9	.009	.07	—	−.001	−.007
1985-1	2.9	.009	.08	—	−.001	−.007
1985-2	2.9	.008	.08	—	−.001	−.007
1985-3	2.7	.008	.07	—	−.001	−.007
1985-4	2.5	.008	.06	—	−.001	−.006

— = Number is less than 0.0005.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases personal disposable income by 1 percent from its base scenario levels in the four quarters of 1980 and then returns to its base scenario levels thereafter.

Table 7—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term 1-percent rise in personal disposable income[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	101.05	0.355	0.025	0.194
1980-2	7.3	0.021	98.90	.332	.022	.172
1980-3	7.7	.024	100.20	.324	.022	.173
1980-4	8.6	.028	100.97	.336	.022	.157
1981-1	9.8	.031	101.81	.357	.022	.155
1981-2	14.4	.041	101.38	.336	.020	.153
1981-3	14.3	.043	102.18	.327	.021	.155
1981-4	15.0	.048	102.28	.336	.020	.147
1982-1	16.3	.050	102.57	.358	.020	.145
1982-2	19.6	.054	102.33	.336	.019	.145
1982-3	19.2	.057	102.25	.324	.019	.145
1982-4	19.7	.061	103.98	.338	.019	.142
1983-1	21.1	.063	105.28	.363	.019	.141
1983-2	24.0	.065	105.89	.342	.019	.143
1983-3	23.4	.068	107.55	.333	.019	.146
1983-4	23.6	.072	109.39	.348	.020	.144
1984-1	25.2	.074	111.54	.376	.020	.147
1984-2	28.1	.076	112.74	.354	.019	.150
1984-3	27.3	.079	113.78	.344	.019	.152
1984-4	27.6	.083	114.61	.356	.020	.147
1985-1	29.2	.085	114.39	.381	.019	.144
1985-2	32.1	.085	116.50	.360	.019	.154
1985-3	31.3	.089	116.81	.347	.019	.160
1985-4	31.2	.093	117.74	.360	.019	.156

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases personal disposable income by 1 percent from its base scenario levels beginning in 1980-1 and extending through the end of the simulation.

cent. Production is larger throughout the simulation in response to the resulting higher prices, with the unitless relative multipliers increasing to 0.088 percent for 1985.

These scenarios imply that the major demand and price impacts occur simultaneously and for the duration of the income impact, with unitless relative multipliers of 0.32 to 0.38 percent and 0.14 to 0.19 percent, respectively. Subsequent demand and price impacts beyond the impact period converge quickly to zero. Production impacts begin with a one-quarter lag and are generally much smaller, with unitless relative multipliers below 0.031 percent in the short- and medium-term income impact scenarios. The production impacts gradually increase to 0.093 percent at the end of the sixth impact year in the long-term income impact scenario.

The impacts resulting from short-, medium-, and long-term income increases of $10 billion from the base scenario levels (about 0.4 percent) show adjustment patterns and implications similar to those from the 1-percent income impact scenarios of tables 5-7 (see Appendix B). Although the absolute income impact simulations are not specifically discussed, the resulting multipliers may be useful in responding to outlook and policy questions formulated in terms of absolute income changes rather than relative income changes.

Feed Price Multipliers

Feed prices in the model are a weighted average of corn and soybean meal prices. Dairy sector impacts for short-, medium-, and long-term 1-percent increases in feed prices are derived by assuming that corn and soybean meal prices each increase 1 percent (tables 8-10). Because the indirect effects on commercial milk demand are negligible, impacts are shown only for milk production and milk prices. Absolute and relative changes from the base scenario solution are shown from the first quarter of 1980 through the end of 1985.

In the short-term feed price impact scenario, corn, soybean meal, and feed prices are increased 1 percent from their base scenario levels in the first quarter of 1980 and then return to the base scenario levels afterwards (table 8). In response to the temporarily higher production costs, milk production declines 8.6 million pounds (−0.025 percent) during the following quarter and, although remaining below base scenario levels throughout the simulation, rises to near the base levels afterwards. As in the income impact scenarios, the second quarter production impacts here again converge to the base levels over subsequent years more slowly than other quarters, due largely to the fourth order autoregressive term in the production per cow equation. Reduced production pushes milk prices up slightly (0.02 percent) during the quarter following the feed price impact, with only the quarter 1 year later having another relative impact on milk prices exceeding 0.01 percent.

For a medium-term 1-percent rise in feed prices, corn, soybean meal, and feed prices are increased from their base scenario levels during each of the four quarters of 1980 and then return to the base scenario levels afterwards (table 9). Production impacts—responding to the higher production costs—again start with a one-quarter lag, with the largest decline being about 15 million pounds (−0.05 percent) before gradually converging toward the base scenario levels. Similar to the short-term feed price impacts, lower production pushes milk prices up slightly beginning in the quarter following the feed price impact. These adjustments are again small, since the largest relative impact on milk prices is 0.03 percent.

Table 8—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term 1-percent rise in feed prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	0	0
1980-2	−8.6	−0.025	0.003	0.020
1980-3	−.6	−.002	—	.001
1980-4	−1.1	−.003	—	.002
1981-1	−1.1	−.003	—	.002
1981-2	−4.7	−.013	.001	.011
1981-3	−.4	−.001	—	.001
1981-4	−.9	−.003	—	.002
1982-1	−.9	−.003	—	.002
1982-2	−2.8	−.008	.001	.006
1982-3	−.4	−.001	—	.001
1982-4	−.9	−.003	—	.002
1983-1	−.8	−.002	—	.002
1983-2	−1.8	−.005	.001	.004
1983-3	−.5	−.001	—	.001
1983-4	−.8	−.002	—	.002
1984-1	−.7	−.002	—	.002
1984-2	−1.2	−.003	—	.003
1984-3	−.5	−.002	—	.001
1984-4	−.7	−.002	—	.002
1985-1	−.7	−.002	—	.002
1985-2	−1.0	−.003	—	.002
1985-3	−.6	−.002	—	.001
1985-4	−.6	−.002	—	.002

— = Number is less than 0.0005.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases feed prices by 1 percent from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter.

Table 9—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term 1-percent rise in feed prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	0	0
1980-2	−8.6	−0.025	0.003	0.020
1980-3	−8.5	−.026	.003	.020
1980-4	−11.8	−.039	.004	.025
1981-1	−14.6	−.046	.004	.031
1981-2	−8.1	−.023	.002	.018
1981-3	−7.5	−.023	.002	.017
1981-4	−8.2	−.026	.002	.018
1982-1	−8.8	−.027	.003	.019
1982-2	−5.6	−.016	.002	.013
1982-3	−5.4	−.016	.002	.012
1982-4	−5.6	−.017	.002	.012
1983-1	−5.9	−.018	.002	.013
1983-2	−4.4	−.012	.001	.010
1983-3	−4.2	−.012	.001	.010
1983-4	−4.2	−.013	.001	.009
1984-1	−4.4	−.013	.001	.010
1984-2	−3.8	−.010	.001	.009
1984-3	−3.6	−.010	.001	.008
1984-4	−3.5	−.010	.001	.008
1985-1	−3.6	−.010	.001	.008
1985-2	−3.4	−.009	.001	.009
1985-3	−3.2	−.009	.001	.008
1985-4	−3.0	−.009	.001	.007

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases feed prices by 1 percent from its base scenario levels in the four quarters of 1980 and then returns to its base scenario levels thereafter.

For the long-term feed price impact scenario, corn, soybean meal, and feed prices are increased permanently by 1 percent from their base scenario levels starting in the first quarter of 1980 (table 10). Milk production is smaller throughout the simulation in response to the higher production costs, with the unitless relative multipliers increasing to about −0.09 percent in the last 2 years of the simulation. Milk prices rise to 1 cent per cwt above the base scenario levels, giving unitless relative multipliers of about 0.08 percent in the last 2 years of the simulation.

These scenarios imply that milk production and milk price adjustments resulting from feed price increases are quite small, although feed prices tend to change relatively more than personal disposable income, cattle prices, or milk prices (see table 4). Impacts on milk production begin with a one-quarter lag, with unitless relative multipliers less than −0.05 percent in the short- and medium-term feed price impact scenarios, while gradually increasing to −0.09 percent toward the end of the long-term feed price impact scenario. Milk price impacts also begin with a one-quarter lag, with unitless relative multipliers less than 0.04 percent in the short- and medium-term feed price impact scenarios, while gradually increasing to about 0.08 percent toward the end of the long-term scenario.

The impacts resulting from short-, medium-, and long-term feed price increases of 10 cents per cwt (about 1.8 percent) from the base scenario levels (Appendix B) show adjustment patterns and implications similar to those from the 1-percent feed price impact scenarios (tables 8-10).[3] Although the absolute feed price impact simulations are not specifically discussed, the resulting multipliers may be useful in responding to outlook and policy questions formulated in terms of absolute feed price changes rather than relative feed price changes.

Table 10—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term 1-percent rise in feed prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	0	0
1980-2	−8.6	−0.025	0.003	0.020
1980-3	−8.5	−.026	.003	.020
1980-4	−11.8	−.039	.004	.025
1981-1	−14.6	−.046	.004	.031
1981-2	−19.0	−.054	.006	.043
1981-3	−19.0	−.058	.006	.043
1981-4	−20.2	−.064	.006	.044
1982-1	−21.4	−.065	.007	.047
1982-2	−24.7	−.069	.008	.057
1982-3	−24.3	−.072	.007	.056
1982-4	−24.0	−.074	.007	.054
1983-1	−25.2	−.075	.008	.056
1983-2	−28.4	−.077	.009	.067
1983-3	−28.0	−.081	.009	.065
1983-4	−29.6	−.091	.009	.066
1984-1	−31.4	−.093	.010	.072
1984-2	−33.5	−.090	.010	.081
1984-3	−32.4	−.094	.010	.077
1984-4	−31.7	−.096	.010	.073
1985-1	−32.7	−.095	.010	.075
1985-2	−34.7	−.092	.011	.087
1985-3	−32.6	−.092	.010	.084
1985-4	−31.7	−.094	.010	.078

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases feed prices by 1 percent from its base scenario levels beginning in 1980-1 and extending through the end of the simulation.

Cattle Price Multipliers

Cattle prices represent the profitability of competing beef enterprises. Impacts for short-, medium-, and long-term 1-percent increases in cattle prices are shown only for milk production and milk prices because the indirect effects on commercial milk demand are negligible (tables 11-13). Again, absolute and relative changes from the base scenario solution are shown from the first quarter of 1980 through the end of 1985.

In the short-term cattle price impact scenario, cattle prices are increased 1 percent from their base scenario level during the first quarter of 1980 and then return to the base scenario levels afterwards (table 11). In response to the higher profitability of beef enterprises relative to dairy enterprises, milk cow inventories are reduced, and milk production declines. Production impacts during the first year total about 8 million pounds (−0.007 percent) with production converging slowly toward base scenario levels afterwards. Reduced production pushes milk prices up slightly, with first-year impacts of about 0.005 percent.

For the medium-term 1-percent rise in cattle prices, cattle prices are increased from their base scenario levels during each of the four quarters of 1980, and then

[3]To attain a 10-cent-per-cwt rise in feed prices, corn prices were increased by 5.6 cents per bushel and soybean meal prices were increased by $2 per ton.

return to the base scenario levels afterwards (table 12). Production falls from the base scenario levels throughout, with the largest absolute impact about 8 million pounds (−0.024 percent) before production slowly converges toward the base scenario levels. Lower production pushes milk prices up slightly, but these adjustments are again small since the largest relative impact on milk prices is less than 0.02 percent.

For the long-term cattle price impact scenario (table 13), cattle prices are increased permanently by 1 percent from their base scenario levels starting in the first quarter of 1980. Milk production is smaller throughout the simulation with the unitless relative multipliers increasing to about −0.1 percent in the last year of the simulation. Milk prices rise to 1 cent per cwt above the base scenario levels, giving unitless relative multipliers of about 0.09 percent during the last year of the simulation.

These scenarios imply that milk production and milk price adjustments resulting from cattle price increases are quite small. Milk production impacts are less than −0.03 percent in the short- and medium-term cattle price impact scenarios, while gradually increasing to −0.1 percent toward the end of the long-term cattle price impact scenario. Milk price impacts are less than 0.02 percent in the short- and medium-term cattle price impact scenarios, gradually increasing to about 0.09 percent toward the end of the long-term scenario.

Impacts resulting from short-, medium-, and long-term cattle price increases of $1 per cwt (about 1.7 percent) from the base scenario levels (Appendix B) show adjustment patterns and implications similar to those from the 1-percent cattle price impact scenarios (tables 11-13). Although the absolute cattle price impact simulations are not specifically discussed, the resulting multipliers may be useful in responding to outlook and

Table 11—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term 1-percent rise in cattle prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	−2.2	−0.007	0.001	0.005
1980-2	−2.2	−.007	.001	.005
1980-3	−2.0	−.006	.001	.005
1980-4	−1.9	−.006	.001	.004
1981-1	−2.0	−.006	.001	.004
1981-2	−2.0	−.006	.001	.005
1981-3	−1.8	−.006	.001	.004
1981-4	−1.7	−.005	.001	.004
1982-1	−1.8	−.005	.001	.004
1982-2	−1.9	−.005	.001	.004
1982-3	−1.7	−.005	.001	.004
1982-4	−1.6	−.005	—	.004
1983-1	−1.6	−.005	.001	.004
1983-2	−1.7	−.005	.001	.004
1983-3	−1.5	−.004	—	.004
1983-4	−1.4	−.004	—	.003
1984-1	−1.5	−.004	—	.003
1984-2	−1.6	−.004	—	.004
1984-3	−1.4	−.004	—	.003
1984-4	−1.3	−.004	—	.003
1985-1	−1.4	−.004	—	.003
1985-2	−1.5	−.004	—	.004
1985-3	−1.3	−.004	—	.003
1985-4	−1.2	−.004	—	.003

— = Number is less than 0.0005.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases cattle prices by 1 percent from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter.

Table 12—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term 1-percent rise in cattle prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	−2.2	−0.007	0.001	0.005
1980-2	−4.5	−.013	.001	.011
1980-3	−6.2	−.019	.002	.015
1980-4	−7.6	−.025	.002	.016
1981-1	−7.7	−.024	.002	.017
1981-2	−8.3	−.024	.003	.019
1981-3	−7.4	−.023	.002	.017
1981-4	−6.8	−.022	.002	.015
1982-1	−7.0	−.021	.002	.015
1982-2	−7.5	−.021	.002	.018
1982-3	−6.7	−.020	.002	.016
1982-4	−6.3	−.019	.002	.014
1983-1	−6.4	−.019	.002	.014
1983-2	−6.9	−.019	.002	.016
1983-3	−6.1	−.018	.002	.014
1983-4	−5.7	−.017	.002	.013
1984-1	−5.9	−.017	.002	.013
1984-2	−6.3	−.017	.002	.015
1984-3	−5.6	−.016	.002	.013
1984-4	−5.3	−.016	.002	.012
1985-1	−5.5	−.016	.002	.013
1985-2	−5.9	−.016	.002	.015
1985-3	−5.3	−.015	.002	.014
1985-4	−4.9	−.015	.002	.012

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases cattle prices by 1 percent from its base scenario levels in the four quarters of 1980 and then returns to its base scenario levels thereafter.

Table 13—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term 1-percent rise in cattle prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	−2.2	−0.007	0.001	0.005
1980-2	−4.5	−.013	.001	.011
1980-3	−6.2	−.019	.002	.015
1980-4	−7.6	−.025	.002	.016
1981-1	−9.8	−.031	.003	.021
1981-2	−12.7	−.036	.004	.029
1981-3	−13.4	−.041	.004	.030
1981-4	−14.1	−.045	.004	.031
1982-1	−16.4	−.050	.005	.036
1982-2	−19.8	−.055	.006	.046
1982-3	−19.6	−.058	.006	.045
1982-4	−20.0	−.062	.006	.045
1983-1	−22.4	−.066	.007	.050
1983-2	−26.2	−.071	.008	.061
1983-3	−25.1	−.073	.008	.058
1983-4	−25.0	−.077	.008	.056
1984-1	−27.6	−.082	.008	.063
1984-2	−31.8	−.086	.010	.077
1984-3	−30.3	−.088	.009	.072
1984-4	−30.2	−.091	.009	.069
1985-1	−32.9	−.096	.010	.076
1985-2	−37.4	−.099	.011	.094
1985-3	−35.4	−.100	.011	.091
1985-4	−34.9	−.104	.011	.087

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases cattle prices by 1 percent from its base scenario levels beginning in 1980-1 and extending through the end of the simulation.

policy questions formulated in terms of absolute cattle price changes rather than relative cattle price changes.

Milk Price Multipliers

Supply and demand responses for any commodity to changes in their own prices are important characteristics of any model. However, because milk prices are endogenous in the aggregate dairy sector model, the derivation of the corresponding multipliers required a departure from the usual procedure of changing an exogenous variable to perform the alternative scenario simulations. Milk prices were instead altered from their base scenario levels by using an autonomous shock, with the milk price equation in the model remaining endogenous to allow fully dynamic feedback effects to prices resulting from supply and demand responses.[4]

In the short-term milk price impact scenario, milk price is increased 1 percent from its base scenario level during the first quarter of 1980 with no change imposed afterwards (table 14). Because of the initially higher milk prices, commercial use falls 14 million pounds (−0.05 percent) during the impact quarter but is essentially unchanged from the base scenario thereafter. Also in response to the initially higher prices, milk production rises 37 million pounds (0.11 percent) during the following quarter. Impacts during the next three quarters range from 0.009 to 0.016 percent. Then, mainly reflecting the fourth order autoregressive term in the production per cow equation, a production impact of 20 million pounds (0.06 percent) occurs during the second quarter of 1981.

Convergence of second quarter production to the base levels over subsequent years occurs more slowly than production in other quarters, with impacts during the second quarters of the next 2 years of 12 million pounds (0.03 percent) and 8 million pounds (0.02 percent). Because of the initially reduced demand, the feedback effects result in a reduction in the milk price impact from the imposed 1-percent rise to a 0.97-percent rise during the impact quarter. Then, with no further autonomous price changes imposed, the increased production pushes milk prices below the base scenario levels. Following the pattern of the production impacts, further price impacts are largest during second quarters of subsequent years.

For a medium-term 1-percent rise in milk prices, milk prices are increased from the base scenario levels during each of the four quarters of 1980 with no change imposed afterwards (table 15). Similar to the short-term milk price impact scenario, commercial use falls by 12 to 14 million pounds during each of the impact quarters, implying a unitless relative multiplier of about −0.043 percent for the first year. Production impacts—responding to the initially higher prices—again start with a one-quarter lag and then build to about 53 million pounds (0.17 percent) before converging gradually toward the base scenario levels. As in the

[4]An alternative approach would have exogenized milk prices in both the base simulation and the alternative simulations. This, however, would have ignored the important feedback effects which would occur in the marketplace.

Table 14—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term 1-percent rise in milk prices[1]

Year and quarter	Milk production: Absolute	Milk production: Relative	Commercial milk disappearance: Absolute	Commercial milk disappearance: Relative	Milk price: Absolute	Milk price: Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	−14.10	−0.050	0.124	0.973
1980-2	36.6	0.107	1.21	.004	−.011	−.087
1980-3	2.9	.009	.10	—	−.001	−.007
1980-4	5.0	.016	.16	.001	−.002	−.011
1981-1	5.0	.016	.15	.001	−.002	−.011
1981-2	20.4	.058	.62	.002	−.006	−.046
1981-3	2.2	.007	.07	—	−.001	−.005
1981-4	4.5	.014	.13	—	−.001	−.010
1982-1	4.3	.013	.12	—	−.001	−.010
1982-2	12.2	.034	.35	.001	−.004	−.028
1982-3	2.3	.007	.06	—	−.001	−.005
1982-4	4.1	.013	.11	—	−.001	−.009
1983-1	3.9	.012	.11	—	−.001	−.009
1983-2	8.0	.022	.22	.001	−.002	−.019
1983-3	2.5	.007	.07	—	−.001	−.006
1983-4	3.6	.011	.10	—	−.001	−.008
1984-1	3.5	.010	.09	—	−.001	−.008
1984-2	5.7	.015	.15	—	−.002	−.014
1984-3	2.6	.008	.07	—	−.001	−.006
1984-4	3.3	.010	.09	—	−.001	−.008
1985-1	3.2	.009	.08	—	−.001	−.007
1985-2	4.5	.012	.11	—	−.001	−.011
1985-3	2.7	.008	.07	—	−.001	−.007
1985-4	3.1	.009	.08	—	−.001	−.008

— = Number is less than 0.0005.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases milk prices by 1 percent from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter except for fully dynamic feedback effects which are allowed throughout the simulation.

Table 15—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term 1-percent rise in milk prices[1]

Year and quarter	Milk production: Absolute	Milk production: Relative	Commercial milk disappearance: Absolute	Commercial milk disappearance: Relative	Milk price: Absolute	Milk price: Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	−14.10	−0.050	0.124	0.973
1980-2	36.6	0.107	−12.43	−.042	.114	.887
1980-3	39.4	.122	−12.13	−.039	.113	.881
1980-4	43.8	.144	−12.96	−.043	.124	.880
1981-1	53.3	.167	1.65	.006	−.016	−.114
1981-2	35.6	.101	1.08	.004	−.011	−.081
1981-3	33.4	.101	.98	.003	−.010	−.076
1981-4	31.7	.101	.92	.003	−.010	−.069
1982-1	33.5	.102	.96	.003	−.010	−.073
1982-2	25.1	.070	.71	.002	−.008	−.058
1982-3	23.8	.070	.66	.002	−.007	−.055
1982-4	22.5	.070	.63	.002	−.007	−.050
1983-1	23.6	.070	.66	.002	−.007	−.052
1983-2	19.9	.054	.55	.002	−.006	−.047
1983-3	18.7	.054	.51	.002	−.006	−.043
1983-4	17.5	.054	.47	.002	−.005	−.039
1984-1	18.2	.054	.49	.002	−.006	−.042
1984-2	17.0	.046	.45	.001	−.005	−.041
1984-3	15.8	.045	.41	.001	−.005	−.037
1984-4	14.8	.045	.38	.001	−.005	−.034
1985-1	15.4	.045	.40	.001	−.005	−.035
1985-2	15.2	.041	.39	.001	−.005	−.038
1985-3	14.0	.040	.35	.001	−.004	−.036
1985-4	13.1	.039	.33	.001	−.004	−.032

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases milk prices by 1 percent from its base scenario levels in the four quarters of 1980 and then returns to its base scenario levels thereafter except for fully dynamic feedback effects which are allowed throughout the simulation.

short-term milk price impact scenario, the initially lower demand results in a reduction in the milk price impact from the imposed 1-percent rise to a 0.97-percent rise during the first impact quarter. Then, the effects of the production increases pull the milk price impact down further during the next three impact quarters from the imposed 1-percent rise to about 0.88 percent. With no further autonomous price changes imposed, milk prices then fall below the base scenario levels, but converge toward the base solution in subsequent years following the pattern of the production impacts.

For the long-term milk price impact scenario (table 16), a permanent 1-percent increase from base scenario levels is imposed on the milk price equation starting in the first quarter of 1980, with dynamic feedback effects allowed. Commercial use falls throughout the simulation period, but as supply and demand adjustments reduce the price impacts, commercial use converges toward the base scenario, and the unitless relative multipliers decline from −0.05 to −0.02 percent. Milk production is larger throughout the simulation in response to the higher prices, with the unitless relative multipliers increasing to 0.42 percent for 1985. The feedback effects reduce the price impacts throughout the simulation from the imposed 1-percent rise down to 0.61 percent during the last simulation year (1985).

These scenarios illustrate the dynamic own-price multipliers for supply and demand in the aggregate dairy sector model. Production impacts begin with a one-quarter lag. In the short-term and medium-term price impact scenarios, production multipliers are between 0.10 and 0.17 percent before converging to zero, while in the long-term price impact scenario, the

Table 16—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term 1-percent rise in milk prices[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	−14.10	−0.050	0.124	0.973
1980-2	36.6	0.107	−12.43	−.042	.114	.887
1980-3	39.4	.122	−12.13	−.039	.113	.881
1980-4	43.8	.144	−12.96	−.043	.124	.880
1981-1	53.3	.167	−12.41	−.044	.122	.861
1981-2	76.6	.218	−10.64	−.035	.107	.802
1981-3	75.0	.227	−10.43	−.033	.108	.806
1981-4	78.4	.250	−10.73	−.035	.113	.806
1982-1	88.1	.268	−10.30	−.036	.109	.784
1982-2	104.6	.290	−8.98	−.029	.096	.735
1982-3	100.2	.297	−8.98	−.028	.098	.746
1982-4	102.7	.318	−9.34	−.030	.102	.749
1983-1	112.3	.333	−9.20	−.032	.100	.728
1983-2	126.1	.342	−7.99	−.026	.089	.682
1983-3	119.6	.347	−8.22	−.025	.092	701
1983-4	120.8	.370	−8.49	−.027	.096	.707
1984-1	130.1	.385	−7.99	−.027	.091	.682
1984-2	142.7	.385	−6.94	−.022	.080	.635
1984-3	134.6	.389	−7.24	−.022	.085	.660
1984-4	135.7	.410	−7.58	−.024	.089	.668
1985-1	145.3	.423	−7.22	−.024	.086	645
1985-2	158.1	.421	−5.88	−.018	.071	.582
1985-3	147.7	.418	−5.87	−.017	.071	.600
1985-4	146.3	.435	−6.25	−.019	.076	.618

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases milk prices by 1 percent from its base scenario levels beginning in 1980-1 and extending through the end of the simulation, with fully dynamic feedback effects allowed throughout the simulation.

production multipliers increase further to about 0.42 percent. Commercial use impacts are small, starting at about -0.05 percent and then diminishing as the price impacts are reduced. The net price impacts illustrate the importance of feedback effects. The net effect on prices is reduced in each of the three scenarios from the imposed 1-percent rise. In the short- and medium-term price impact scenarios, price impacts are initially between 0.88 and 0.97 percent. Following the imposed price impact period, prices then fall below base scenario levels and converge back toward the base levels. In the long-term price impact scenario, price impacts are lowered to about 0.61 percent by 1985. While there would likely be larger production impacts and additional reductions in the net price impacts in subsequent years, it appears that these multipliers are converging. The duration of the adjustments in response to the permanent (long-term) price impacts reflects the biological constraints to rapid production increases (implicitly represented in the model by the autoregressive term in the cow inventory equation).

Tables presenting the impacts resulting from short-, medium-, and long-term milk price increases of 10 cents per cwt from the base scenario levels (about 0.7 percent), again keeping the milk price equation endogenous to allow feedback effects, are shown in Appendix B. Adjustment patterns and implications are similar to those from the 1-percent milk price impact scenarios of tables 14-16. Although the absolute milk price impact simulations are not specifically discussed, the resulting multipliers may be useful in responding to outlook and policy questions formulated in terms of absolute milk price changes rather than relative milk price changes.

Policy Applications

Net Government removals of dairy products reached nearly 17 billion pounds (milk-equivalent, milkfat basis) in 1983, requiring about $2.6 billion in net Government expenditures. The Dairy and Tobacco Adjustment Act of 1983 provided incentives to bring dairy marketings more in line with consumption to address this growing problem. The new law lowered the support price by 50 cents per cwt; had provisions for additional support reductions in 1985; mandated a 50-cent-per-cwt deduction on milk marketed from December 1983 through March 1985; mandated a 15-cent-per-cwt deduction for product promotion, research, and nutritional education; and had a voluntary 15-month paid diversion program which started on January 1, 1984. Although this law helped reduce removals in 1984 to 8.6 billion pounds and expenditures to about $1.3 billion, lower milk prices and higher feed costs were also important factors, especially among nonparticipating producers *(2)*.

Since the diversion program and the 50-cent-per-cwt deduction ended on March 31, 1985, a number of policy alternatives have been considered. One major policy instrument is the dairy price support. Support for manufacturing grade milk was set at $12.60 per cwt on December 1, 1983. It was then reduced by 50 cents per cwt on April 1, 1985, with a further 50-cent-per-cwt cut in the support price made on July 1, 1985.

Two important policy issues can be addressed using the aggregate dairy sector model. First, the model is used to estimate the effects of the 15-month paid diversion program. Second, the model is used to examine some implications of three price support policy alternatives, ranging from leaving the price support at its 1984 level of $12.60 per cwt to lowering the price support to $10 per cwt. Although these model applications and results abstract from any structural changes that the policies may affect, the simulations' results and corresponding impacts provide useful reference points.

Effects of the Dairy Diversion Program

The model was simulated from the first quarter of 1984 through the end of 1990 to depict the no-diversion program scenario. Because there are no specific policy variables in the model through which to represent the diversion program incentives, this simulation is indicative of what would have occurred without the diversion program. For comparison, actual data for 1984 and the first two quarters of 1985 represent the initial periods in the diversion program scenario. Then, results of a second simulation of the model starting in the third quarter of 1985 and extending through the end of 1990 were used in the diversion program scenario. Other dairy provisions in the Dairy and Tobacco Adjustment Act of 1983; the April 1, 1985, termination of the 50-cent-per-cwt deduction on milk marketings; and the April 1, 1985, and July 1, 1985, reductions in the support price were all assumed in both scenarios. Identical values of exogenous variables were used in both scenarios except for the farm use of milk. In the no-diversion program scenario, farm use of milk was adjusted from actual levels for the 15-month duration of the program to account for larger than normal onfarm milk use that occurred under the program. Actual values were used for historical periods for all other exogenous variables. For forecasted periods, typical seasonal patterns at relatively constant annual levels were used for exogenous dairy sector variables. Feed costs, personal disposable income, and the consumer price index (CPI) were assumed to increase moderately.

Table 17 compares the two scenarios for six key dairy sector variables. Absolute and relative changes of the diversion program scenario from the no-diversion program scenario show the impacts of the diversion program from what would have occurred without the diversion program.

Milk cow inventories were reduced by 2.5 percent in 1984 under the diversion program and were 2.8 percent lower in the first quarter 1985. After the end of the diversion program, however, milk cow inventories

Table 17—Simulated effects of the January 1984 through March 1985 dairy diversion program

Year and quarter	Change from no-diversion scenario											
	Milk cow inventory		Milk production per cow		Milk production		Commercial milk use		Net Government milk removals		Farm price of milk	
	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Thousand	*Percent*	*Pounds*	*Percent*	*Mil. lbs.*	*Percent*	*Mil. lbs.*	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1984-1	-197	-1.8	31	1.0	-284	-0.8	-524	-1.8	66	1.5	0.21	1.6
1984-2	-301	-2.7	-48	-1.4	-1,524	-4.1	579	1.8	-2,262	-45.0	.37	2.9
1984-3	-303	-2.7	-53	-1.7	-1,535	-4.4	-97	-.3	-1,606	-65.6	.53	4.2
1984-4	-305	-2.7	-33	-1.1	-1,279	-3.8	-50	-.2	-1,432	-71.6	.97	7.4
1985-1	-307	-2.8	-2	-.1	-975	-2.8	-680	-2.3	-490	-10.6	.49	3.7
1985-2	-151	-1.4	1	0	-498	-1.3	8	0	-506	-10.7	.41	3.4
1985-3	-143	-1.3	-18	-.6	-646	-1.8	-16	0	-629	-28.5	.20	1.7
1985-4	-140	-1.3	-12	-.4	-554	-1.6	-13	0	-541	-32.2	.17	1.4
1986-1	-135	-1.2	3	.1	-395	-1.1	-9	0	-385	-8.6	.12	1.0
1986-2	-132	-1.2	4	.1	-421	-1.1	-10	0	-410	-7.8	.13	1.1
1986-3	-130	-1.2	-6	-.2	-478	-1.3	-12	0	-467	-25.9	.15	1.3
1986-4	-127	-1.1	-3	-.1	-416	-1.2	-10	0	-406	-25.7	.13	1.1
1987-1	-124	-1.1	4	.1	-345	-1.0	-8	0	-337	-7.7	.10	.8
1987-2	-120	-1.1	4	.1	-374	-1.0	-8	0	-366	-7.2	.11	.9
1987-3	-119	-1.1	0	0	-385	-1.1	-9	0	-376	-25.1	.12	1.0
1987-4	-116	-1.0	2	.1	-342	-1.0	-8	0	-334	-20.9	.10	.8
1988-1	-113	-1.0	4	.1	-312	-.9	-7	0	-305	-7.7	.09	.7
1988-2	-111	-1.0	4	.1	-340	-.9	-8	0	-333	-6.9	.10	.9
1988-3	-108	-1.0	2	.1	-328	-.9	-7	0	-321	-27.8	.10	.8
1988-4	-106	-1.0	3	.1	-297	-.9	-7	0	-291	-22.5	.09	.7
1989-1	-103	-.9	4	.1	-287	-.8	-6	0	-281	-7.3	.08	.7
1989-2	-102	-.9	4	.1	-311	-.8	-6	0	-305	-6.8	.10	.9
1989-3	-99	-.9	3	.1	-290	-.8	-6	0	-284	-35.2	.09	.7
1989-4	-97	-.9	3	.1	-267	-.8	-6	0	-262	-25.4	.08	.6
1990-1	-95	-.9	4	.1	-265	-.7	-6	0	-259	-7.0	.08	.7
1990-2	-93	-.8	4	.1	-286	-.7	-6	0	-281	-6.6	.09	.8
1990-3	-91	-.8	3	.1	-262	-.7	-5	0	-256	-53.1	.08	.7
1990-4	-89	-.8	3	.1	-244	-.7	-5	0	-239	-30.3	.07	.6
1984	-276	-2.5	-103	-.8	-4,623	-3.3	-92	-.1	-5,235	-37.7	.52	4.0
1985	-185	-1.7	-30	-.2	-2,674	-1.9	-702	-.5	-2,166	-16.4	.31	2.5
1986	-131	-1.2	-3	0	-1,709	-1.2	-42	0	-1,668	-12.7	.13	1.1
1987	-120	-1.1	9	.1	-1,446	-1.0	-34	0	-1,412	-11.3	.11	.9
1988	-109	-1.0	14	.1	-1,277	-.9	-28	0	-1,249	-11.2	.09	.7
1989	-100	-.9	15	.1	-1,155	-.8	-24	0	-1,130	-11.1	.09	.7
1990	-92	-.8	15	.1	-1,057	-.7	-22	0	-1,036	-11.3	.08	.7

rose sharply, resulting in the inventory impact being reduced to 1.4 percent below the no-diversion program scenario during the second quarter of 1985. With higher prices in the diversion program scenario, milk cow inventories then slowly converge toward the no-diversion program scenario levels and are less than 1 percent lower in the last 2 years of the simulations.

Milk production per cow is initially 1.0 percent higher in the diversion program scenario because program participants would have culled their least productive cows. Milk production per cow then falls below rates that would have occurred, consistent with program participants feeding less concentrate to limit output. By 1987 and continuing through the remainder of the simulation interval, the smaller herd has slightly higher productivity in the diversion program scenario, again implying the culling of the least productive cows.

Milk production in the diversion program scenario for 1984 is consequently 3.3 percent below what would have occurred without the program. Production then gradually moves toward the no-diversion program scenario levels and is less than 1 percent lower in the last 3 years of the simulations.

The largest effects of the diversion program on commercial use are in 1984 and the first quarter of 1985, the 15-month period that the diversion program covered. Higher prices appear to have generally reduced commercial use from what would have occurred without the diversion program. The normal seasonal use pattern appears to have shifted between the first two quarters of 1984. Commercial use impacts are small starting in the second quarter of 1985, reflecting the indirect effects of the program on prices.

Net Government removals of dairy products were reduced by the diversion program, particularly during the 15 months of the program. The estimated decrease in removals in 1984 is 5.2 billion pounds. In subsequent years, however, impacts on net Government removals mirror the small production impacts, being reduced to a 1.0-billion-pound decrease from the no-diversion program scenario levels by 1990.

Milk prices are estimated to be 52 and 31 cents per cwt higher in 1984 and 1985 than would have occurred without the diversion program, reflecting lower production. As production moves back toward the no-program scenario levels, price impacts are reduced to 8 cents per cwt in 1990.

While the impacts presented here are based on a comparison of point estimates from simulations of the model, the beyond-sample performance of the model (discussed in the model validation section) suggests that the point estimates should be reasonably accurate. The magnitudes of these estimated impacts and the beginning of a return to the simulated no-diversion program levels suggest that a temporary diversion program policy results in only a temporary and partial solution to the underlying dairy supply/demand imbalance problem.

Effects of Various Price Support Alternatives

Three scenarios of the aggregate dairy sector model were simulated from the third quarter of 1985 through 1990 to examine some effects of alternative price support levels. The milk price support is the major policy instrument in the model affecting the dairy sector. The level of support is the primary factor in determining milk prices which then affect supply and demand. After adjusting farm-level milk prices for the level of deductions, the resulting effective milk prices affect producers' decisions regarding milk cow inventories and production per cow. When effective prices exceed total costs, expansion is expected. When effective prices are below total costs, production is expected to decline, although it may not in the short run if prices exceed variable costs *(9)*. The price support also affects demand because commercial use is partly determined by the farm-level milk price.

The three policy scenarios simulated assume alternative dairy price support levels through 1990 (table 18). Scenario 1 holds the price support at $12.60 per cwt through 1990 and represents what would have occurred if the price support had been left unchanged at 1984 levels.

Scenario 2 reduces the price support from $12.60 per cwt to $12.10 per cwt on April 1, 1985, and to $11.60 per cwt on July 1, 1985. Support is then assumed to remain unchanged through 1990 in this scenario.

Scenario 3 assumes that following the two 50-cent-per-cwt price support reductions of scenario 2, support is further reduced to $10 per cwt on October 1, 1985, re-

Table 18—Alternative dairy price support assumptions

Year and quarter	Scenario 1	Scenario 2	Scenario 3
		$/cwt	
1985-1	12.60	12.60	12.60
1985-2	12.60	12.10	12.10
1985-3	12.60	11.60	11.60
1985-4	12.60	11.60	10.00
1986-1	12.60	11.60	10.00
1986-2	12.60	11.60	10.00
1986-3	12.60	11.60	10.00
1986-4	12.60	11.60	10.00
1987-1	12.60	11.60	10.00
1987-2	12.60	11.60	10.00
1987-3	12.60	11.60	10.00
1987-4	12.60	11.60	10.00
1988-1	12.60	11.60	10.00
1988-2	12.60	11.60	10.00
1988-3	12.60	11.60	10.00
1988-4	12.60	11.60	10.00
1989-1	12.60	11.60	10.00
1989-2	12.60	11.60	10.00
1989-3	12.60	11.60	10.00
1989-4	12.60	11.60	10.00
1990-1	12.60	11.60	10.00
1990-2	12.60	11.60	10.00
1990-3	12.60	11.60	10.00
1990-4	12.60	11.60	10.00

maining at that level through the end of 1990. The results of scenario 3 are indicative of the effects of any future reductions in support below the $11.60 level simulated in scenario 2.

All scenarios were simulated from the third quarter of 1985 through the fourth quarter of 1990. In each scenario, the 15-cent-per-cwt deduction for product promotion, research, and nutritional education mandated by the Dairy and Tobacco Adjustment Act of 1983 was assumed to remain in effect throughout the simulation period. The exogenous imports, stocks, and farm use variables were assumed to follow typical seasonal patterns at relatively constant annual levels. Feed costs, personal disposable income, and the CPI were assumed to increase moderately. In scenario 1, historical data for the second quarter of 1985 were adjusted to reflect the assumed higher price support than actually occurred.

Table 19 shows the simulated values for six key dairy sector variables for the three scenarios. With the price support held at the 1984 level of $12.60 per cwt (scenario 1), milk cow inventories begin to build while production per cow rises throughout the simulation period.[5] Milk production consequently increases. Commercial use increases more slowly than production does through 1987, leading to increasing net Government removals. Commercial use then increases slightly faster than production does in the last 3 years of the simulation. Consequently, net Government removals decline some but remain above 12 billion pounds each year. After averaging over $13 per cwt in 1985, milk prices decline to slightly below $13 per cwt during the remaining years of the simulation. The corresponding per-unit receipts are above projected total economic costs, thereby providing the economic incentive for expansion.[6]

For scenario 2, the two 50-cent-per-cwt reductions in support and the resulting lower prices cause milk cow inventories to rise more slowly than in scenario 1 through 1986 before leveling off at about 11 million head. The increases in production per cow are also smaller than in scenario 1. Production consequently rises more slowly throughout the simulation. Lower market prices lead to higher commercial use, with increases exceeding the production rises by 1987. While this results in declining net Government removals, the basic supply/demand imbalance remaining leaves removals above 8 billion pounds each year. Although prices are lower than in scenario 1, the corresponding per-unit receipts remain above projected total economic costs, providing the economic incentive for the smaller expansion.

For scenario 3, lower support prices and the resulting lower milk prices lead to declining milk cow inventories starting in 1986. Production per cow gains are slowed relative to the results of earlier scenarios. Importantly, these changes lead to a turning point in milk

[5]Because of seasonality in the supply, utilization, and price data, comparisons are made on a four-quarter-earlier basis.

[6]Although outside the formal framework of the current model, the results can be embedded into the cost-of-production framework of (3) and (11). To derive per-unit receipts, an assumed $1.10 to $1.20 per cwt to represent receipts from culled cows, calves, and replacements is added to price estimates from the model. Production cost projections for 1985-90 are based on historical data and discussions in (3) and (11), an assumed 4- to 5-percent general inflation rate, and assumed moderate changes in feed prices.

production during the second quarter of 1986, with production declining from year-earlier levels. Although the dairy herd's genetic improvement leads to a reversal of the production declines later in the simulation, subsequent production gains remain lower than in the other scenarios. Lower market prices again lead to increasing commercial use, resulting in a significant narrowing of the supply/demand imbalance and a substantial lowering of net Government removals. Prices fall sharply in 1986 before increasing somewhat through the remainder of the simulation. The corresponding per-unit receipts are somewhat below likely total economic costs starting in 1986, providing the economic incentive for the production decline. Per-unit receipts remain below likely total economic costs in subsequent years, and provide the economic incentive for the milk cow inventory reduction, although the rise in effective prices, the implicit culling of the least productive cows, and the herd's genetic improvement all contribute to the offsetting increase in production per cow during the last 2 years of the simulation.

The results of these three policy simulations suggest that rising production per cow and rising or stable milk cow inventories will again lead to increases in milk production near those in commercial disappearance unless price supports are substantially reduced. In the absence of substantial price support reductions, net Government removals of dairy products would consequently be expected to remain large through the end of the decade (see fig. 6). Alternative support levels between $10 per cwt and $11.60 per cwt would also lead to declining removals. Such levels, however, would cause the narrowing of the supply/demand imbalance to occur more slowly than indicated in the $10-per-cwt scenario.

Although this analysis is based on point estimates from model simulations, the beyond-sample performance of the model discussed in the model validation section again suggests that the point estimates should be reasonably accurate. There are, however, some factors which could have affected the simulation results. In particular, some differences from the simulation results could occur because these simulations used one set of assumptions regarding feed costs, macroeconomic conditions, and dairy industry adoption of emerging technologies. These factors, however, largely affect the magnitudes of the effects presented while leaving the qualitative implications unchanged.

Policy Implications

Analysis of the effects of the dairy diversion program implies that a temporary diversion program policy results in only a temporary and partial solution to the underlying dairy supply/demand imbalance problem. Analysis of the effects of alternative price supports suggests that the price support can be an effective policy tool to address the supply/demand imbalance issue in the dairy sector. A substantial reduction in support from current levels, however, would be required to reduce the Government's role in the dairy sector.

Because there are some factors underlying these policy analyses which could affect the estimates, some differences in the magnitudes of those effects could occur although the qualitative conclusions would remain valid. An adjustable dairy support price mechanism such as discussed in (*7*) or as proposed in numerous farm bills in 1985 (*12*), however, would address the basic supply/demand imbalance in the dairy sector while allowing for adjustments to changes in factors underlying these policy analyses.

Figure 6
Simulated net Government removals

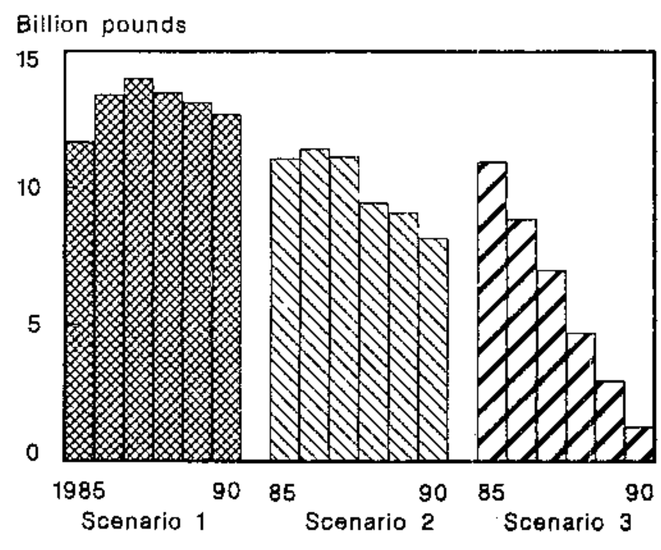


Table 19—Alternative dairy price support simulations, selected results

Year and quarter	Milk cow inventory	Milk production per cow	Milk production	Commercial milk use	Net Government milk removals	Farm price of milk
	Thousand	*Pounds*	———*Mil. lbs.*	———	———	*$/cwt*
Scenario 1:						
1985-1	10,817	3,109	33,632	29,342	4,114	13.67
1985-2	10,971	3,393	37,231	32,372	4,277	12.98
1985-3	11,011	3,187	35,093	33,613	1,791	12.83
1985-4	11,045	3,057	33,758	32,641	1,489	13.22
1986-1	11,055	3,166	35,003	30,472	4,461	13.17
1986-2	11,055	3,449	38,135	32,747	5,302	12.54
1986-3	11,076	3,236	35,838	34,061	1,871	12.71
1986-4	11,100	3,094	34,350	33,016	1,764	13.13
1987-1	11,107	3,204	35,590	30,867	4,683	13.08
1987-2	11,105	3,487	38,722	33,247	5,425	12.48
1987-3	11,123	3,270	36,369	34,619	1,870	12.68
1987-4	11,145	3,124	34,820	33,525	2,020	13.11
1988-1	11,151	3,233	36,053	31,268	4,455	13.04
1988-2	11,146	3,515	39,173	33,749	5,385	12.46
1988-3	11,162	3,296	36,786	35,180	1,737	12.69
1988-4	11,184	3,147	35,200	34,041	1,894	13.11
1989-1	11,188	3,257	36,442	31,678	4,534	13.02
1989-2	11,181	3,538	39,561	34,256	5,265	12.47
1989-3	11,197	3,320	37,173	35,749	1,554	12.71
1989-4	11,218	3,174	35,607	34,565	1,776	13.12
1990-1	11,222	3,283	36,838	32,095	4,513	13.00
1990-2	11,214	3,562	39,949	34,774	5,136	12.47
1990-3	11,229	3,345	37,564	36,325	1,368	12.73
1990-4	11,250	3,202	36,022	35,096	1,661	13.12
1985	10,961	12,746	139,714	127,969	11,671	13.18
1986	11,072	12,946	143,326	130,297	13,398	12.89
1987	11,120	13,085	145,501	132,258	13,998	12.84
1988	11,161	13,191	147,212	134,237	13,470	12.83
1989	11,196	13,289	148,783	136,248	13,129	12.83
1990	11,229	13,392	150,373	138,291	12,678	12.83
Scenario 2:						
1985-1	10,817	3,109	33,632	29,342	4,114	13.67
1985-2	10,971	3,393	37,231	32,412	4,237	12.50
1985-3	11,003	3,176	34,949	33,684	1,577	11.97
1985-4	11,022	3,037	33,478	32,710	1,140	12.39
1986-1	11,019	3,148	34,682	30,545	4,069	12.28
1986-2	11,005	3,430	37,740	32,815	4,839	11.69
1986-3	11,011	3,211	35,361	34,121	1,333	11.95
1986-4	11,023	3,068	33,820	33,076	1,174	12.37
1987-1	11,018	3,178	35,015	30,930	4,045	12.17
1987-2	11,003	3,459	38,057	33,306	4,701	11.71
1987-3	11,008	3,241	35,673	34,671	1,122	11.99
1987-4	11,020	3,096	34,114	33,578	1,261	12.40
1988-1	11,015	3,204	35,296	31,324	3,641	12.28
1988-2	10,998	3,484	38,314	33,801	4,473	11.75

—Continued

Table 19—Alternative dairy price support simulations, selected results—Continued

Year and quarter	Milk cow inventory	Milk production per cow	Milk production	Commercial milk use	Net Government milk removals	Farm price of milk
	Thousand	*Pounds*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*$/cwt*
Scenario 2 (Continued):						
1988-3	11,004	3,265	35,929	35,226	832	12.05
1988-4	11,015	3,119	34,355	34,088	1,002	12.45
1989-1	11,010	3,228	35,541	31,729	3,582	12.30
1989-2	10,992	3,507	38,548	34,303	4,205	11.81
1989-3	10,998	3,290	36,183	35,791	522	12.11
1989-4	11,010	3,146	34,643	34,608	769	12.49
1990-1	11,005	3,254	35,813	32,141	3,442	12.32
1990-2	10,988	3,532	38,805	34,816	3,949	11.85
1990-3	10,994	3,316	36,459	36,363	226	12.16
1990-4	11,007	3,175	34,951	35,135	551	12.52
1985	10,953	12,716	139,289	128,148	11,068	12.63
1986	11,014	12,856	141,603	130,556	11,415	12.07
1987	11,012	12,973	142,859	132,485	11,129	12.09
1988	11,008	13,072	143,894	134,440	9,949	12.13
1989	11,003	13,171	144,914	136,431	9,079	12.18
1990	10,998	13,278	146,028	138,455	8,167	12.21
Scenario 3:						
1985-1	10,817	3,109	33,632	29,342	4,114	13.67
1985-2	10,971	3,393	37,231	32,412	4,237	12.50
1985-3	11,003	3,176	34,949	33,684	1,577	11.97
1985-4	11,022	3,037	33,478	32,830	1,020	10.92
1986-1	10,994	3,115	34,242	30,662	3,511	10.83
1986-2	10,956	3,397	37,219	32,927	4,206	10.30
1986-3	10,940	3,180	34,789	34,222	661	10.68
1986-4	10,931	3,039	33,225	33,177	478	11.08
1987-1	10,905	3,133	34,161	31,033	3,089	10.95
1987-2	10,868	3,413	37,095	33,402	3,643	10.45
1987-3	10,854	3,197	34,696	34,758	58	10.84
1987-4	10,848	3,056	33,146	33,667	204	11.22
1988-1	10,824	3,155	34,154	31,416	2,408	11.05
1988-2	10,788	3,433	37,038	33,887	3,111	10.59
1988-3	10,775	3,217	34,666	35,303	−507	10.98
1988-4	10,770	3,075	33,122	34,167	−311	11.36
1989-1	10,748	3,179	34,171	31,811	2,129	11.14
1989-2	10,713	3,456	37,021	34,379	2,602	10.72
1989-3	10,702	3,242	34,694	35,860	−1,036	11.11
1989-4	10,700	3,102	33,196	34,680	−748	11.46
1990-1	10,679	3,207	34,247	32,216	1,801	11.22
1990-2	10.646	3,482	37,063	34,885	2,139	10.83
1990-3	10,637	3,270	34,776	36,425	−1,519	11.23
1990-4	10,636	3,133	33,321	35,200	−1,143	11.55
1985	10,953	12,716	139,289	128,268	10,947	12.26
1986	10,955	12,731	139,474	130,987	8,856	10.72
1987	10,869	12,798	139,099	132,860	6,994	10.87
1988	10,789	12,881	138,979	134,773	4,701	10.99
1989	10,716	12,979	139,082	136,730	2,947	11.11
1990	10,649	13,091	139,408	138,726	1,277	11.20

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Appendix A — Alternative Milk Cow Inventory Equations

The first alternative milk cow inventory equation presented in appendix table 1 incorporates the unemployment rate to represent general economic conditions, following an approach used in a study of factors affecting annual milk production (*1*). Although a reasonably good equation estimate resulted, it did not prove superior to the inventory equation chosen for the model (table 1) for the short- to medium-term forecasting and policy applications of this study. The second alternative milk cow inventory equation was used in earlier versions of the aggregate dairy sector model (see (*14*), for example). It has slightly better single-equation properties than the inventory equation shown in table 1 and results in slightly better model validation statistics than those shown in table 3. To address some structural concerns, however, it is presented here as an alternative inventory equation to that shown in table 1. As for the milk cow inventory equation in table 1, the alternative equations are estimated with no intercept because of high collinearity in the equations with the intercept included. The reported R^2s are derived by squaring the simple correlation between the actual data and the estimated equations' predicted series.

Appendix table 1 — Alternative specifications of the milk cow inventory equation[1]

Alternative specification 1:

$$COWKM = \underset{\substack{(590.70)\\(5.01)^{2}}}{0.990}\ COWKM_{t-1} + \underset{(4.73)}{9.41}\ MIPEFF_{t-1} - \underset{(1.66)}{7.31}\ FDPFM_{t-1} + \underset{(2.11)}{7.52}\ UNEM - \underset{(2.60)}{21.79}\ D1 - \underset{(3.65)}{30.21}\ D2$$

$R^2 = 0.997$ RMSE = 22.17 CV = 0.20

Alternative specification 2:

$$COWKM = \underset{\substack{(994.52)\\(6.73)^{2}}}{0.993}\ COWKM_{t-1} + \underset{(8.81)}{11.70}\ MIPEFF_{t-1} - \underset{(3.96)}{0.261}\ SMPDM_{t-1} - \underset{(3.35)}{24.79}\ D1 - \underset{(4.44)}{32.67}\ D2$$

$R^2 = 0.997$ RMSE = 19.77 CV = 0.18

Note: The t-statistic is reported in parentheses below each coefficient. RMSE is the root mean squared error. CV is the coefficient of variation. The estimation period for each equation is 1971-81.

[1]These milk cow inventory equations are estimated with no intercept because of high collinearity in the equations with the intercept included. The reported R^2s are derived by squaring the simple correlation between the actual data and each estimated equation's predicted series. [2]Number reported is the t-statistic for the test of the coefficient being different from 1.

Appendix B—Dynamic Multipliers Resulting from Absolute Changes in Selected Variables

The tables presented in this appendix show dynamic system multipliers resulting from short-, medium-, and long-term absolute changes in selected variables.

The variables of most interest in the aggregate dairy model for deriving multipliers are personal disposable income, feed prices, cattle prices, and milk prices. Appendix tables 3-5 present the impacts resulting from short-, medium-, and long-term income increases of $10 billion from the base scenario levels. Appendix tables 6-8 present the impacts resulting from short-, medium-, and long-term feed price increases of 10 cents per cwt from the base scenario levels.[7] Appendix tables 9-11 present the impacts resulting from short-, medium-, and long-term cattle price increases of $1 per cwt from the base scenario levels. Appendix tables 12-14 present the impacts resulting from short-, medium-, and long-term autonomous milk price increases of 10 cents per cwt from the base scenario levels with fully dynamic feedback effects allowed. Results of the alternative scenarios are compared with the base solution to derive the dynamic multipliers, presented in terms of the absolute impacts as well as the relative impacts to facilitate use in various of outlook and policy applications.

[7]To attain a 10-cent-per-cwt rise in feed prices, corn prices were increased by 5.6 cents per bushel and soybean meal prices were increased by $2 per ton.

Appendix table 2 — Variable definitions used for alternative specifications of the milk cow inventory equation

Variables	Definition	Units
COWKM	Milk cow inventory	Thousand head
Di	Dummy variable equal to 1 in the i-th quarter, i = 1, 2	N.A.
FDPFM	Feed price[1]	$/cwt
MIPEFF	Effective milk price	$/cwt
SMPDM	Soybean meal price, Decatur, 44-percent protein	$/ton
UNEM	Civilian unemployment rate	Percent

N.A. = Not applicable.
[1]Weighted average of corn price and soybean meal price.

Appendix table 3—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term $10-billion rise in personal disposable income[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	57.00	0.200	0.014	0.110
1980-2	4.1	0.012	.14	—	-.001	-.010
1980-3	.3	.001	.01	—	—	-.001
1980-4	.6	.002	.02	—	—	-.001
1981-1	.6	.002	.02	—	—	-.001
1981-2	2.3	.007	.07	—	-.001	-.005
1981-3	.3	.001	.01	—	—	-.001
1981-4	.5	.002	.01	—	—	-.001
1982-1	.5	.001	.01	—	—	-.001
1982-2	1.4	.004	.04	—	—	-.003
1982-3	.3	.001	.01	—	—	-.001
1982-4	.5	.001	.01	—	—	-.001
1983-1	.4	.001	.01	—	—	-.001
1983-2	.9	.002	.02	—	—	-.002
1983-3	.3	.001	.01	—	—	-.001
1983-4	.4	.001	.01	—	—	-.001
1984-1	.4	.001	.01	—	—	-.001
1984-2	.6	.002	.02	—	—	-.002
1984-3	.3	.001	.01	—	—	-.001
1984-4	.4	.001	.01	—	—	-.001
1985-1	.4	.001	.01	—	—	-.001
1985-2	.5	.001	.01	—	—	-.001
1985-3	.3	.001	.01	—	—	-.001
1985-4	.3	.001	.01	—	—	-.001

— = Number is less than 0.0005 in absolute value.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases personal disposable income by $10 billion from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter.

Appendix table 4—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term $10-billion rise in personal disposable income[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	57.00	0.200	0.014	0.110
1980-2	4.1	0.012	55.26	.185	.012	.096
1980-3	4.3	.013	54.27	.176	.012	.094
1980-4	4.7	.015	52.92	.176	.012	.082
1981-1	5.2	.016	.16	.001	−.002	−.011
1981-2	3.9	.011	.12	—	−.001	−.009
1981-3	3.5	.011	.10	—	−.001	−.008
1981-4	3.3	.011	.10	—	−.001	−.007
1982-1	3.3	.010	.10	—	−.001	−.007
1982-2	2.7	.008	.08	—	−.001	−.006
1982-3	2.5	.007	.07	—	−.001	−.006
1982-4	2.4	.007	.07	—	−.001	−.005
1983-1	2.4	.007	.07	—	−.001	−.005
1983-2	2.1	.006	.06	—	−.001	−.005
1983-3	2.0	.006	.05	—	−.001	−.005
1983-4	1.8	.006	.05	—	−.001	−.004
1984-1	1.9	.006	.05	—	−.001	−.004
1984-2	1.8	.005	.05	—	−.001	−.004
1984-3	1.7	.005	.04	—	−.001	−.004
1984-4	1.6	.005	.04	—	—	−.004
1985-1	1.6	.005	.04	—	—	−.004
1985-2	1.6	.004	.04	—	—	−.004
1985-3	1.5	.004	.04	—	—	−.004
1985-4	1.4	.004	.03	—	—	−.003

— = Number is less than 0.0005 in absolute value.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases personal disposable income by $10 billion from its base scenario levels during the four quarters of 1980 and then returns to its base scenario levels thereafter.

Appendix table 5—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term $10-billion rise in personal disposable income[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	57.00	0.200	0.014	.110
1980-2	4.1	0.012	55.26	.185	.012	.096
1980-3	4.3	.013	54.27	.176	.012	.094
1980-4	4.7	.015	52.92	.176	.012	.082
1981-1	5.2	.016	51.62	.181	.011	.078
1981-2	7.6	.022	50.55	.167	.010	.075
1981-3	7.5	.023	49.17	.157	.010	.073
1981-4	7.7	.024	48.49	.159	.010	.068
1982-1	8.2	.025	48.12	.168	.009	.067
1982-2	9.8	.027	47.47	.156	.009	.066
1982-3	9.5	.028	46.59	.148	.009	.065
1982-4	9.6	.030	46.49	.151	.008	.062
1983-1	10.1	.030	46.54	.161	.008	.061
1983-2	11.4	.031	46.01	.149	.008	.060
1983-3	11.0	.032	45.46	.141	.008	.059
1983-4	10.9	.033	45.07	.143	.008	.057
1984-1	11.5	.034	44.61	.150	.007	.055
1984-2	12.7	.034	44.18	.139	.007	.055
1984-3	12.1	.035	43.70	.132	.007	.054
1984-4	12.0	.036	43.38	.135	.007	.052
1985-1	12.6	.037	43.13	.144	.007	.050
1985-2	13.8	.037	42.72	.132	.006	.051
1985-3	13.1	.037	42.22	.125	.006	.053
1985-4	12.9	.038	41.95	.128	.006	.051

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases personal disposable income by $10 billion from its base scenario level beginning in 1980-1 and extending through the end of the simulation.

Appendix table 6—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term 10-cent-per-cwt rise in feed prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	0	0
1980-2	−11.1	−0.032	0.003	0.026
1980-3	−1.6	−.005	—	.004
1980-4	−2.1	−.007	.001	.005
1981-1	−2.2	−.007	.001	.005
1981-2	−6.5	−.018	.002	.015
1981-3	−1.3	−.004	—	.003
1981-4	−1.9	−.006	.001	.004
1982-1	−1.9	−.006	.001	.004
1982-2	−4.1	−.011	.001	.010
1982-3	−1.3	−.004	—	.003
1982-4	−1.7	−.005	.001	.004
1983-1	−1.7	−.005	.001	.004
1983-2	−2.9	−.008	.001	.007
1983-3	−1.3	−.004	—	.003
1983-4	−1.6	−.005	—	.004
1984-1	−1.6	−.005	—	.004
1984-2	−2.2	−.006	.001	.005
1984-3	−1.3	−.004	—	.003
1984-4	−1.5	−.004	—	.003
1985-1	−1.4	−.004	—	.003
1985-2	−1.8	−.005	.001	.005
1985-3	−1.3	−.004	—	.003
1985-4	−1.3	−.004	—	.003

— = Number is less than 0.0005.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases feed prices by 10 cents per cwt from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter.

Appendix table 7—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term 10-cent-per-cwt rise in feed prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	0	0
1980-2	−11.1	−0.032	0.003	0.026
1980-3	−12.5	−.039	.004	.030
1980-4	−14.4	−.047	.004	.031
1981-1	−16.9	−.053	.005	.036
1981-2	−13.2	−.038	.004	.030
1981-3	−12.1	−.037	.004	.028
1981-4	−11.5	−.037	.003	.025
1982-1	−11.6	−.035	.004	.025
1982-2	−10.0	−.028	.003	.023
1982-3	−9.2	−.027	.003	.021
1982-4	−8.7	−.027	.003	.019
1983-1	−8.9	−.026	.003	.020
1983-2	−8.3	−.022	.003	.019
1983-3	−7.6	−.022	.002	.018
1983-4	−7.1	−.022	.002	.016
1984-1	−7.2	−.021	.002	.017
1984-2	−7.2	−.020	.002	.017
1984-3	−6.6	−.019	.002	.016
1984-4	−6.2	−.019	.002	.014
1985-1	−6.4	−.019	.002	.015
1985-2	−6.6	−.017	.002	.017
1985-3	−5.9	−.017	.002	.015
1985-4	−5.6	−.017	.002	.014

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases feed prices by 10 cents per cwt from its base scenario levels during the four quarters of 1980 and then returns to its base scenario levels thereafter.

Appendix table 8—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term 10-cent-per-cwt rise in feed prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	0	0
1980-2	−11.1	−0.032	0.003	0.026
1980-3	−12.5	−.039	.004	.030
1980-4	−14.4	−.047	.004	.031
1981-1	−16.9	−.053	.005	.036
1981-2	−24.4	−.069	.007	.056
1981-3	−24.8	−.075	.008	.056
1981-4	−26.1	−.083	.008	.057
1982-1	−28.8	−.088	.009	.063
1982-2	−34.6	−.096	.011	.080
1982-3	−34.3	−.101	.010	.079
1982-4	−35.1	−.109	.011	.078
1983-1	−38.0	−.113	.012	.084
1983-2	−43.3	−.117	.013	.102
1983-3	−42.1	−.122	.013	.098
1983-4	−42.3	−.130	.013	.095
1984-1	−45.2	−.134	.014	.103
1984-2	−50.6	−.136	.015	.122
1984-3	−48.8	−.141	.015	.116
1984-4	−48.8	−.148	.015	.112
1985-1	−51.9	−.151	.016	.120
1985-2	−57.5	−.153	.018	.145
1985-3	−55.3	−.157	.017	.142
1985-4	−54.8	−.163	.017	.136

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases feed prices by 10 cents per cwt from its base scenario levels beginning in 1980-1 and extending through the end of the simulation.

Appendix table 9—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term $1-per-cwt rise in cattle prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	−3.4	−0.011	0.001	0.008
1980-2	−3.4	−.010	.001	.008
1980-3	−3.1	−.010	.001	.007
1980-4	−2.9	−.010	.001	.006
1981-1	−3.0	−.009	.001	.006
1981-2	−3.1	−.009	.001	.007
1981-3	−2.8	−.009	.001	.006
1981-4	−2.6	−.008	.001	.006
1982-1	−2.7	−.008	.001	.006
1982-2	−2.9	−.008	.001	.007
1982-3	−2.6	−.008	.001	.006
1982-4	−2.4	−.008	.001	.005
1983-1	−2.5	−.007	.001	.006
1983-2	−2.7	−.007	.001	.006
1983-3	−2.4	−.007	.001	.006
1983-4	−2.2	−.007	.001	.005
1984-1	−2.3	−.007	.001	.005
1984-2	−2.5	−.007	.001	.006
1984-3	−2.2	−.006	.001	.005
1984-4	−2.1	−.006	.001	.005
1985-1	−2.1	−.006	.001	.005
1985-2	−2.3	−.006	.001	.006
1985-3	−2.0	−.006	.001	.005
1985-4	−1.9	−.006	.001	.005

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases cattle prices by $1 per cwt from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter.

Appendix table 10—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term $1-per-cwt rise in cattle prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	−3.4	−0.011	0.001	0.008
1980-2	−7.2	−.021	.002	.017
1980-3	−9.9	−.031	.003	.023
1980-4	−12.2	−.040	.004	.026
1981-1	−12.4	−.039	.004	.027
1981-2	−13.3	−.038	.004	.030
1981-3	−11.9	−.036	.004	.027
1981-4	−11.0	−.035	.003	.024
1982-1	−11.2	−.034	.003	.025
1982-2	−12.1	−.034	.004	.028
1982-3	−10.8	−.032	.003	.025
1982-4	−10.0	−.031	.003	.022
1983-1	−10.3	−.031	.003	.023
1983-2	−11.1	−.030	.003	.026
1983-3	−9.8	−.029	.003	.023
1983-4	−9.1	−.028	.003	.021
1984-1	−9.4	−.028	.003	.021
1984-2	−10.2	−.027	.003	.024
1984-3	−9.0	−.026	.003	.021
1984-4	−8.5	−.026	.003	.019
1985-1	−8.7	−.025	.003	.020
1985-2	−9.4	−.025	.003	.024
1985-3	−8.4	−.024	.003	.022
1985-4	−7.9	−.023	.002	.020

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases cattle prices by $1 per cwt from its base scenario levels during the four quarters of 1980 and then returns to its base scenario levels thereafter.

Appendix table 11—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term $1-per-cwt rise in cattle prices[1]

Year and quarter	Milk production		Milk price	
	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*$/cwt*	*Percent*
1980-1	−3.4	−0.011	0.001	0.008
1980-2	−7.2	−.021	.002	.017
1980-3	−9.9	−.031	.003	.023
1980-4	−12.2	−.040	.004	.026
1981-1	−15.9	−.050	.005	.034
1981-2	−20.7	−.059	.006	.047
1981-3	−22.0	−.067	.007	.050
1981-4	−23.5	−.075	.007	.051
1982-1	−27.5	−.084	.008	.060
1982-2	−33.1	−.092	.010	.077
1982-3	−33.0	−.098	.010	.076
1982-4	−33.9	−.105	.010	.076
1983-1	−38.1	−.113	.012	.085
1983-2	−44.5	−.121	.014	.105
1983-3	−43.1	−.125	.013	.100
1983-4	−43.1	−.132	.013	.097
1984-1	−47.4	−.140	.014	.108
1984-2	−54.8	−.148	.017	.132
1984-3	−52.3	−.151	.016	.124
1984-4	−52.1	−.158	.016	.120
1985-1	−56.8	−.165	.017	.131
1985-2	−64.8	−.172	.020	.163
1985-3	−61.5	−.174	.019	.158
1985-4	−60.6	−.180	.019	.150

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases cattle prices by $1 per cwt from its base scenario levels beginning in 1980-1 and extending through the end of the simulation.

Appendix table 12—Dynamic properties of the aggregate dairy sector model, impacts resulting from a short-term 10-cent-per-cwt rise in milk prices[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	−11.03	−0.039	0.097	0.760
1980-2	28.6	0.084	.95	.003	−.009	−.068
1980-3	2.3	.007	.07	—	−.001	−.005
1980-4	3.9	.013	.12	—	−.001	−.008
1981-1	3.9	.012	.12	—	−.001	−.008
1981-2	15.9	.045	.48	.002	−.005	−.036
1981-3	1.7	.005	.05	—	−.001	−.004
1981-4	3.5	.011	.10	—	−.001	−.008
1982-1	3.4	.010	.10	—	−.001	−.007
1982-2	9.5	.026	.27	.001	−.003	−.022
1982-3	1.8	.005	.05	—	−.001	−.004
1982-4	3.2	.010	.09	—	−.001	−.007
1983-1	3.0	.009	.08	—	−.001	−.007
1983-2	6.2	.017	.17	.001	−.002	−.015
1983-3	2.0	.006	.05	—	−.001	−.005
1983-4	2.8	.009	.08	—	−.001	−.006
1984-1	2.7	.008	.07	—	−.001	−.006
1984-2	4.4	.012	.12	—	−.001	−.011
1984-3	2.1	.006	.05	—	−.001	−.005
1984-4	2.6	.008	.07	—	−.001	−.006
1985-1	2.5	.007	.07	—	−.001	−.006
1985-2	3.5	.009	.09	—	−.001	−.009
1985-3	2.1	.006	.05	—	−.001	−.005
1985-4	2.4	.007	.06	—	−.001	−.006

— = Number is less than 0.0005.

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases milk prices by 10 cents per cwt from its base scenario level in 1980-1 and then returns to its base scenario levels thereafter except for fully dynamic feedback effects which are allowed throughout the simulation.

Appendix table 13—Dynamic properties of the aggregate dairy sector model, impacts resulting from a medium-term 10-cent-per-cwt rise in milk prices[1]

Year and quarter	Milk production		Commercial milk disappearance		Milk price	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	−11.03	−0.039	0.097	0.760
1980-2	28.6	0.084	−9.68	−.032	.089	.691
1980-3	30.7	.095	−9.44	−.031	.088	.686
1980-4	34.2	.112	−9.10	−.030	.087	.618
1981-1	38.7	.122	1.20	.004	−.012	−.083
1981-2	27.5	.078	.83	.003	−.008	−.063
1981-3	25.6	.078	.75	.002	−.008	−.058
1981-4	24.3	.078	.71	.002	−.007	−.053
1982-1	24.5	.075	.71	.002	−.007	−.054
1982-2	19.4	.054	.55	.002	−.006	−.045
1982-3	18.2	.054	.51	.002	−.006	−.042
1982-4	17.2	.053	.48	.002	−.005	−.038
1983-1	17.5	.052	.49	.002	−.005	−.039
1983-2	15.3	.042	.42	.001	−.005	−.036
1983-3	14.2	.041	.39	.001	−.004	−.033
1983-4	13.3	.041	.36	.001	−.004	−.030
1984-1	13.6	.040	.36	.001	−.004	−.031
1984-2	13.0	.035	.34	.001	−.004	−.031
1984-3	12.0	.035	.31	.001	−.004	−.028
1984-4	11.3	.034	.29	.001	−.003	−.026
1985-1	11.6	.034	.30	.001	−.004	−.027
1985-2	11.6	.031	.30	.001	−.004	−.029
1985-3	10.6	.030	.27	.001	−.003	−.027
1985-4	10.0	.030	.25	.001	−.003	−.025

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases milk prices by 10 cents per cwt from its base scenario levels during the four quarters of 1980 and then returns to its base scenario levels thereafter, except for fully dynamic feedback effects which are allowed throughout the simulation.

Appendix table 14—Dynamic properties of the aggregate dairy sector model, impacts resulting from a long-term 10-cent-per-cwt rise in milk prices[1]

Year and quarter	Milk production: Absolute	Milk production: Relative	Commercial milk disappearance: Absolute	Commercial milk disappearance: Relative	Milk price: Absolute	Milk price: Relative
	Mil. lbs.	*Percent*	*Mil. lbs.*	*Percent*	*$/cwt*	*Percent*
1980-1	0	0	−11.03	−0.039	0.097	0.760
1980-2	28.6	0.084	−9.68	−.032	.089	.691
1980-3	30.7	.095	−9.44	−.031	.088	.686
1980-4	34.2	.112	−9.10	−.030	.087	.618
1981-1	38.7	.122	−8.73	−.031	.086	.605
1981-2	56.4	.161	−8.00	−.026	.080	.602
1981-3	56.6	.172	−7.78	−.025	.080	.601
1981-4	59.0	.188	−7.60	−.025	.080	.571
1982-1	63.9	.194	−7.40	−.026	.078	.563
1982-2	76.6	.212	−6.93	−.023	.074	.567
1982-3	75.5	.223	−6.83	−.022	.075	.567
1982-4	77.1	.239	−6.78	−.022	.074	.543
1983-1	82.2	.244	−6.67	−.023	.073	.531
1983-2	[illegible]	.252	−6.27	−.020	.070	.535
1983-3	90.4	.263	−6.26	−.019	.070	.534
1983-4	90.7	.278	−6.20	−.020	.070	.516
1984-1	95.8	.284	−5.99	−.020	.069	.514
1984-2	106.0	.286	−5.66	−.018	.066	.518
1984-3	102.6	.296	−5.69	−.017	.067	.518
1984-4	102.7	.311	−5.68	−.018	.067	.500
1985-1	108.3	.315	−5.47	−.018	.065	.489
1985-2	118.5	.315	−5.15	−.016	.062	.509
1985-3	114.4	.324	−5.20	−.015	.063	.532
1985-4	113.6	.338	−5.19	−.016	.063	.513

[1]Based on a comparison of results of two fully dynamic simulations of the aggregate dairy sector model. Base scenario uses actual exogenous data throughout. Alternative scenario increases milk prices by 10 cents per cwt from its base scenario levels beginning in 1980-1 and extending through the end of the simulation, with fully dynamic feedback effects allowed throughout the simulation.

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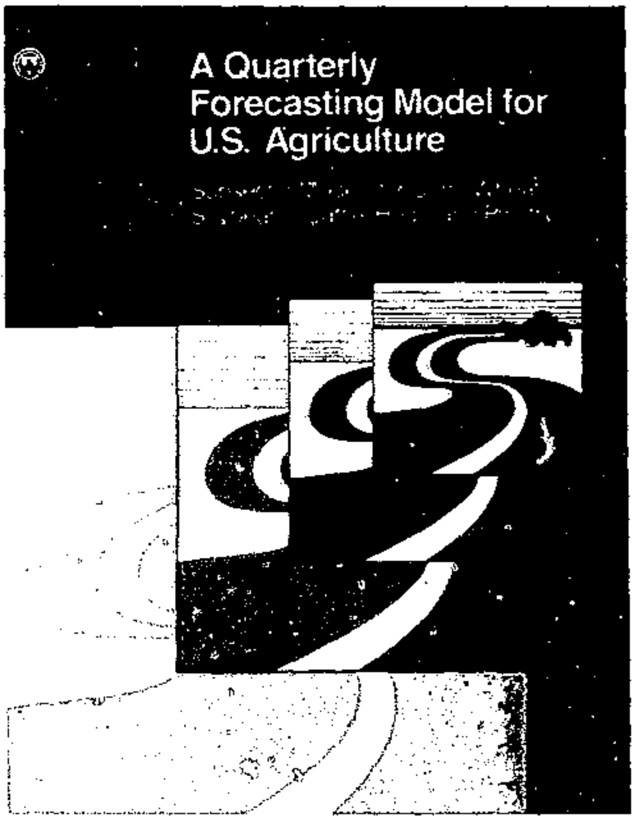

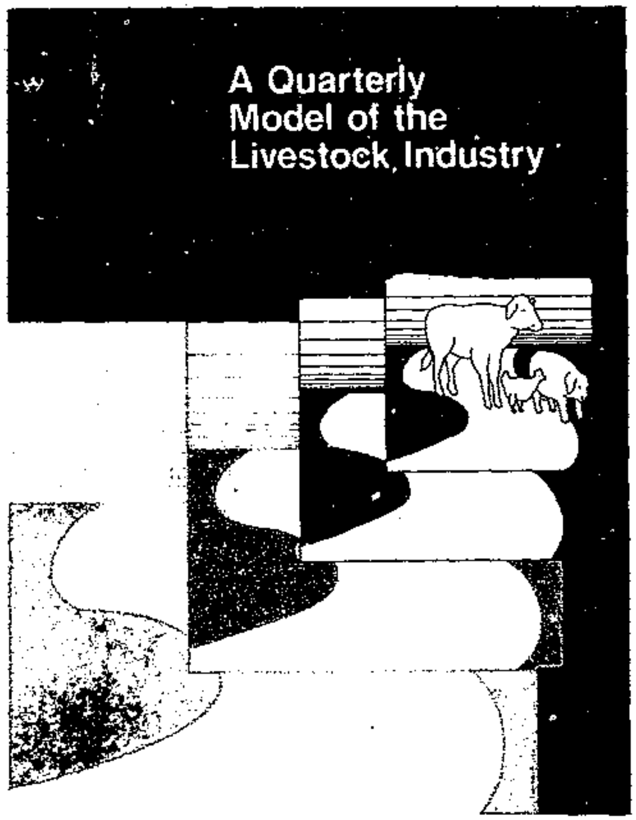

A Quarterly Forecasting Model for U.S. Agriculture: Subsector Models for Corn, Wheat, Soybeans, Cattle, Hogs, and Poultry, by Paul C. Westcott and David B. Hull. TB-1700. May 1985. 52 pp. $2.00. SN: 001-019-00390-1.

Provides quarterly forecasts for major agricultural commodities used in outlook and policy analysis. This report presents subsector models for six commodities (corn, wheat, soybeans, cattle, hogs, and poultry), chosen because of their importance in cross-commodity linkages within the agricultural sector. Although relatively small, the agriculture model described here is large enough to help identify links within the agriculture sector and links with other sectors.

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A Quarterly Model of the Livestock Industry, by Richard P. Stillman. TB-1711. Dec. 1985. 40 pp. $1.50. SN: 001-019-00414-2.

Provides quarterly forecasts of livestock prices and quantities. The model in this report incorporates both behavioral and biological equations to project beef, pork, and broiler quantities and prices used by outlook and situation analysts. The model is estimated over the period 1970-81 using OLS (ordinary least squares) estimation procedures. The model is also evaluated for the period 1982-84 to test its performance outside the data base. The model's performance was acceptable given the conditions affecting the livestock sector during the periods studied.

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