An Analysis of Policy Alternatives to the Dairy Price Support Program

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This paper investigates the impacts of alternative federal dairy policies on the U.S. dairy sector. In addition to the current dairy price support program, five alternatives are investigated: (1) immediate deregulation, (2) gradual deregulation, (3) target price-deficiency payment program without supply control, (4) target price-deficiency payment program with supply control, and (5) mandatory supply control. An econometric model of the national dairy industry is used to simulate quarterly equilibrium price and quantity values at the farm and wholesale levels for each policy over the period 1980–90. Consumers are better off under both immediate and gradual deregulation, as well as the target price-deficiency payment scenarios because prices are lower, enabling them to consume more dairy products. Farmers, as a group, are better off under the two target price-deficiency payment program and supply control scenarios, where milk prices and producer surplus are highest.

The U.S. dairy industry has operated under the current dairy price support program (DPSP) since 1949. The program is intended to stabilize dairy farmer income and lessen the seasonal instability in milk prices. The DPSP indirectly supports the farm milk price by standing ready to purchase unlimited quantities of storable manufactured dairy products at specified purchase prices through the Commodity Credit Corporation (CCC). The government thus attempts to maintain the market price for raw milk at or near the support price by increasing the farm demand for raw milk when necessary. The DPSP acts much like a buffer stock mechanism with purchases during the spring "flush production" period and releases in the "slack production" periods typically in the fall and winter.

In the early- and mid-1980s, chronic excess production relative to commercial needs led to CCC purchases under the DPSP that were excessively large (over 10% of production being removed during the peak years). The surpluses were due in large part to several increases in the milk support price in the late 1970s and early 1980s. The government attempted to deal with the problem by introducing two voluntary supply control programs—the 1984–85 Milk Diversion Program (MDP) and the 1986–87 Dairy Termination Program (DTP)—and by linking the support price to estimated CCC purchases. Since 1981, the support price declined from $13.39 per hundredweight to its current level of $10.10.

Recently, several farm organizations have criticized the DPSP on the grounds that the support level is too low. In June 1993, several members of Congress and Secretary Espy met with dairy farmers in Pennsylvania to discuss alternatives to the DPSP. Agricultural support programs have become targeted for elimination by some in order to reduce the federal deficit, as evidenced by the recent termination of the honey, wool, and mohair price support programs. Consequently, policy makers may take a serious look at alternatives to the DPSP in the debate over the next farm bill.

The purpose of this paper is to investigate the market impacts of alternative federal dairy policies. In addition to the current DPSP, five alternatives are investigated: (1) immediate deregulation, where the DPSP is simply eliminated, (2) gradual deregulation, where the purchase prices for dairy products are decreased by 10% per year for the entire simulation period, (3) a target price-deficiency payment program without supply control, (4) a target price-deficiency payment program with supply control to contain government costs, and (5) a mandatory supply control program. Since there have been two recent studies examining voluntary supply control policies for dairy (Dixon, Susanto, and Berry; Bausell, Belsley, and Smith), this type of policy is not examined here, however, the MDP and DTP are part of the baseline scenario.

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Conceptual Model

The model considers the dairy industry's wholesale and farm sectors. The retail sector is excluded because available national consumption data are commercial disappearance at the wholesale rather than retail level. Four types of wholesalers are represented in the model: fluid milk, frozen dairy products, cheese, and butter processors.[1]

Two major federal programs currently regulate dairy prices: federal milk marketing orders and the DPSP. The federal order program is included in all policy scenarios with the simplifying assumption of a single federal milk marketing order. The inclusion of the federal order program for all policy scenarios is reasonable since federal orders are not a critical part of the policy debate related to the DPSP. There is discussion of modifying or eliminating the federal order program, but this is a separate policy issue. The single national federal order is captured in the model by constraining prices processors pay for raw milk to be minimum class prices. That is, fluid milk processors are required to pay the higher Class I price, while cheese processors pay the lower Class III price. Federal milk marketing orders all currently utilize three product classes with Class I being fluid products, Class II being soft manufactured dairy products, and Class III being hard manufactured dairy products. A two-class system is assumed in this study, with all fluid products in Class I and all manufactured products in Class II. Hence, the term "Class II price" in this paper refers to the price paid for milk used in manufactured dairy products and is the same as the Minnesota-Wisconsin (M-W) price. Since the Class II and Class III prices typically only differ by a marginal amount, this is not a limiting assumption.

The DPSP is included in the baseline and the gradual deregulation policy scenario, but is eliminated in the immediate deregulation, target price-deficiency payment, and supply control scenarios. The DPSP is incorporated into the model by constraining the wholesale market cheese and butter prices to be equal to the government purchase prices. Since the government is willing to purchase unlimited quantities of these products at announced purchase prices, the program indirectly supports the farm milk price by increasing farm-level milk demand.

The wholesale market for each of the four dairy products is defined by a set of supply and demand functions and an equilibrium condition. The wholesale fluid milk and frozen product markets have the following general specification:

$$(1.1) \qquad Q^{wdi} = f(P^{wi} | S^{wdi}),$$

$$(1.2) \qquad Q^{wsi} = f(P^{wi} | S^{wsi}),$$

$$(1.3) \qquad Q^{wsi} = Q^{wdi},$$

where: Q^{wdi} and Q^{wsi} are wholesale demand and supply, respectively, for product i (i = fluid milk or frozen products), P^{wi} is the wholesale price of product i, S^{wdi} is a vector of wholesale demand shifters for product i including income, generic advertising expenditures, and prices of substitutes, and S^{wsi} is a vector of wholesale supply shifters for product i including the price of farm milk (Class I price for fluid milk and Class II price for frozen products), other input costs, and lagged supply.

The DPSP directly affects the wholesale cheese and butter markets through CCC purchases at announced purchase prices. As a result, the butter and cheese wholesale market equilibrium conditions are different than those for the fluid milk and frozen wholesale markets. The wholesale cheese and butter markets have the following general specification:

$$(2.1) \qquad Q^{wdi} = f(P^{wi} | S^{wdi}),$$

$$(2.2) \qquad Q^{wsi} = f(P^{wi} | S^{wsi}),$$

$$(2.3) \qquad Q^{wsi} = Q^{wdi} + \Delta INV^i + Q^{gi},$$

where: Q^{wdi} and Q^{wsi} are wholesale demand and supply, respectively, for product i (i = cheese or butter), P^{wi} is the wholesale price of product i, S^{wdi} is a vector of wholesale demand shifters for product i, and S^{wsi} is a vector of wholesale supply shifters for product i. The vectors of demand and supply shifters contain variables similar to those in the fluid and frozen product equations. The variable, ΔINV^i, is change in commercial inventories for product i, which is assumed to be exogenous in the model. The variable, Q^{gi} is CCC purchases of product i.

As previously mentioned, the DPSP is incorporated by constraining the wholesale market cheese and butter prices to be equal to their respective CCC purchase prices, i.e.:

$$(3.1) \qquad P^{wc} = P^{gc},$$

$$(3.2) \qquad P^{wb} = P^{gb},$$

where: P^{gc} and P^{gb} are the CCC purchase prices for cheese and butter, respectively. The assumption that the support prices for cheese and butter are always binding is plausible because government

[1] Fluid milk, frozen products, cheese, and butter are expressed on a milkfat equivalent basis in the model. Since all quantities are expressed on a milkfat basis, nonfat dry milk is not included in the model.

removals of cheese were positive in all but one quarter, and government removals of butter were positive in all but five quarters from 1975 through 1990.[2]

The farm milk market is defined by the milk supply function:

$$(4) \qquad Q^{fms} = f(E(P^{fm})|S^{fms})$$

where: Q^{fms} is farm raw milk supply, $E(P^{fm})$ is the expected farm milk price, and S^{fms} is a vector of milk supply shifters including the price of slaughter cows, feed costs, and lagged milk supply. As in the model developed by LaFrance and de Gorter, a perfect foresight specification is used for the expected farm milk price.[3]

Under the federal milk marketing order program, milk handlers pay Class I and II prices, and farmers receive a weighted average of the class prices—the blend price. With the weights equal to the utilization of milk among products, the blend price is:

$$(5.1) \qquad P^{fm} = \frac{(P^{II} + d) * Q^{wfs} + P^{II} * Q^{wfzs} + P^{II} * Q^{wcs} + P^{II} * Q^{wbs}}{Q^{wfs} + Q^{wfzs} + Q^{wcs} + Q^{wbs}}$$

where P^{II} is the Class II price, d is the fixed Class I differential (the Class I price is equal to P^{II} + d), Q^{wfs} is wholesale fluid milk supply, Q^{wfzs} is wholesale frozen product supply, Q^{wcs} is wholesale cheese supply, and Q^{wbs} is wholesale butter supply.

The model is closed by the equilibrium condition:

$$(5.2) \qquad Q^{fms} = Q^{wfs} + Q^{wfzs} + Q^{wcs} + Q^{wbs} + FUSE + OTHER,$$

where: *FUSE* is on-farm use of milk and *OTHER* is milk used in dairy products other than fluid milk, frozen products, butter, or cheese. Both of these variables represent a small share of total milk production and are treated as exogenous. The model contains 13 endogenous variables, and 13 equations and identities (see Table 2 for variable definitions).

Estimated Model

The wholesale and farm equations were estimated using two stage least squares with quarterly data from 1975 through 1990. To deal with simultaneity bias between price and quantity, instrumental variables were constructed for all prices (wholesale fluid milk and frozen product prices, Class II price, and farm milk price) by regressing them on all exogenous variables in the wholesale and farm markets. All equations in the model are of double-log functional form. Estimation results for the structural equations are presented in Table 1. All variables and data sources are defined in Table 2.

In the wholesale per capita fluid milk demand equation, the CPI for nonalcoholic beverages was used as a proxy for the price of fluid milk substitutes. Generic fluid milk advertising was included to capture the impacts of generic advertising on fluid milk demand (Ward and Dixon). Similar to Liu et al. and Kaiser et al., a four quarter, second-order polynomial distributed lag, with both end point restrictions imposed, was specified for generic fluid milk advertising. The variables SIN_1 and COS_1, which represent the first wave of the sine and cosine, respectively (Doran and Quilkey), were included to capture seasonality in fluid milk demand.

In the wholesale per capita frozen product demand equation, unlike the demand functions for the three other dairy products, the price of frozen product substitutes produced inferior statistical results and therefore was omitted. The specification of the price to income ratio is consistent with the zero degree homogeneity assumption for price and income (Phlips). Since generic advertising on frozen products from 1975 through 1990 was inconsequential, this variable was not included in the frozen product demand equation.

In the wholesale per capita cheese demand equation, the CPI for meat was included as a proxy for the price of cheese substitutes. Deflated per capita income appears to have virtually no effect on cheese demand, as evidenced by its insignificant coefficient. Generic cheese advertising was included to capture the impacts of generic advertising on cheese demand (Blaylock and Blisard) and was modeled analogously to the fluid advertising

[2] A theoretically more appealing approach would be to recognize that there are actually four market regimes possible: (1) $P^{wc} > P^{gc}$ and $P^{wb} > P^{gb}$, (2) $P^{wc} > P^{gc}$ and $P^{wb} = P^{gb}$, (3) $P^{wc} = P^{gc}$ and $P^{wb} > P^{gb}$, or (4) $P^{wc} = P^{gc}$ and $P^{wb} = P^{gb}$. Under this approach, one should use a simultaneous switching regression procedure to estimate the model in order to correct for selectivity bias due to the switching between regimes (Liu et al.). However, applying this procedure to the present model would be rather complicated since cheese and butter are considered separately in the model, and the potential benefits of doing so were judged to be minimal since market prices for cheese and butter were not higher than their purchase prices for the majority of quarters over this period (1975–90).

[3] Several empirical specifications for price expectations were considered. However, over the period 1980–90, the milk price in the next quarter was fairly predictable because of the very high correlation between the observable support price and the farm milk price, and the stable seasonal pattern in the milk price. Hence, a perfect foresight assumption in a quarterly model seems plausible. Also, the perfect foresight assumption is appropriate for the supply control, target price-deficiency payment, and gradual deregulation scenarios because the milk price, under these scenarios, is always close to the government mandated price and easily predicted. However, it should be noted that the price expectations process would change under the immediate deregulation scenario, and this should be kept in mind when examining the results of this scenario.

Table 1. Results for the Econometric Dairy Model[1]

Wholesale Fluid Milk Demand:

$$\ln(Q^{wfd}/POP) = \underset{(-19.9)}{-2.378} - \underset{(-2.4)}{.041 \ln(P^{wf}/P^{bev})} + \underset{(6.6)}{.252 \ln(INCOME/CPI)} + \underset{(8.1)}{.005 \ln DGFAD}$$
$$+ \underset{(8.1)}{.008 \ln DGFAD_{-1}} + \underset{(8.1)}{.009 \ln DGFAD_{-2}} + \underset{(8.1)}{.008 \ln DGFAD_{-3}} + \underset{(8.1)}{.005 \ln DGFAD_{-4}} - \underset{(-13.5)}{.067 \ln T}$$
$$+ \underset{(10.7)}{.021\, SIN_1} + \underset{(16.1)}{.031\, COS_1} + \mu^{wfd} \qquad R^2 = .94;\ DW = 1.5$$

Wholesale Frozen Product Demand:

$$\ln(Q^{wfzd}/POP) = \underset{(-55.5)}{-4.746} - \underset{(-4.9)}{.159 \ln(P^{wfz}/INCOME)} - \underset{(-3.8)}{.027 \ln T} - \underset{(-31.1)}{.148\, SIN_1} - \underset{(-33.1)}{.157\, COS_1}$$
$$\underset{(-6.7)}{-.022\, COS_2} + \mu^{wfzd} \qquad R^2 = .97;\ DW = 1.6$$

Wholesale Cheese Demand:

$$\ln(Q^{wcd}/POP) = \underset{(-3.3)}{-5.059} - \underset{(-2.4)}{.353 \ln(P^{gc}/P^{mea})} - \underset{(-.04)}{.015 \ln(INCOME/CPI)} + \underset{(4.6)}{.046\, COS_2}$$
$$+ \underset{(1.6)}{.003 \ln GCAD} + \underset{(1.6)}{.005 \ln GCAD_{-1}} + \underset{(1.6)}{.006 \ln GCAD_{-2}} + \underset{(1.6)}{.005 \ln GCAD_{-3}} + .003 \ln GCAD_{-4} \qquad R^2 = .58;\ DW = 1.6$$

Wholesale Butter Demand:

$$\ln(Q^{wbd}/POP) = \underset{(-1.8)}{-2.610} - \underset{(-2.3)}{.267 \ln(P^{gb}/P^{fat})} + \underset{(1.5)}{1.027 \ln(INCOME/CPI)} + \underset{(0.9)}{.002 \ln DGBAD}$$
$$\underset{(-2.2)}{-.00011\, T^2} + \underset{(5.5)}{.109\, COS_1} + \underset{(1.9)}{.027\, COS_2} + \mu^{wbd} \qquad R^2 = .38;\ DW = 1.9$$

Wholesale Fluid Milk Supply:

$$\ln Q^{wfs} = \underset{(3.4)}{.322} + \underset{(6.4)}{.142 \ln(P^{wf}/(P^{II}+d))} - \underset{(-2.7)}{.016 \ln(P^{fe}/(P^{II}+d))} + \underset{(6.8)}{.641 \ln(Q^{wfs})_{-1}}$$
$$+ \underset{(1.4)}{.135 \ln(Q^{wfs})_{-4}} + \underset{(8.3)}{.041\, COS_1} + \underset{(2.1)}{.004\, COS_2} + \underset{(1.8)}{(1/(1 + .274\, L))}\, \mu^{wfs} \qquad R^2 = .96;\ Dh = -.4$$

Wholesale Frozen Product Supply:

$$\ln Q^{wfzs} = \underset{(5.8)}{.494} + \underset{(1.0)}{.071 \ln(P^{wfz}/P^{II})} + \underset{(1.9)}{.255 \ln(Q^{wfzs})_{-4}} + \underset{(6.2)}{.058 \ln T} - \underset{(-5.3)}{.110\, SIN_1}$$
$$\underset{(-5.8)}{-.118\, COS_1} - \underset{(-3.6)}{.016\, COS_2} + \underset{(3.0)}{.377\, \mu_{-1}^{wfzs}} \qquad R^2 = .98;\ Dh = 1.4$$

Wholesale Cheese Supply:

$$\ln Q^{wcs} = \underset{(13.3)}{2.349} + \underset{(3.1)}{.268 \ln(P^{gc}/P^{II})} - \underset{(3.9)}{.306 \ln(MWAGE/P^{II})} + \underset{(15.3)}{.010\, T}$$
$$- \underset{(-2.0)}{.038\, DTG} - \underset{(-7.5)}{.054\, COS_1} + \underset{(3.9)}{.020\, COS_2} + \underset{(9.1)}{.782\, \mu^{wcs}} \qquad R^2 = .94;\ DW = 1.3$$

Wholesale Butter Supply:

$$\ln Q^{wbs} = \underset{(4.2)}{1.457} + \underset{(2.7)}{.274 \ln(P^{gb}/P^{II})} + \underset{(3.8)}{.446 \ln(Q^{wbs})_{-1}} + \underset{(4.1)}{.004\, T} - \underset{(-1.7)}{.057\, MDP}$$
$$- \underset{(-2.3)}{.077\, DTG} + \underset{(14.7)}{.214\, SIN_1} + \underset{(1.1)}{.028\, COS_1} + \mu^{wbs} \qquad R^2 = .87;\ Dh = 1.8$$

1.3

Farm Milk Supply:

$$\ln Q^{fms} = \underset{(5.6)}{2.584} + \underset{(1.7)}{.076 \ln(P^{fm}/P^{feed})} + \underset{(-2.8)}{.087 \ln(P^{cow}/P^{pfr})} + \underset{(0.7)}{.052 \ln Q^{fms}_{-1}}$$
$$+ \underset{(1.7)}{.211 \ln Q^{fms}} + \underset{(5.4)}{.003\, T} - \underset{(-2.7)}{.026\, MDP} - \underset{(-3.0)}{.033\, DTP} - \underset{(-5.6)}{.046\, COS_1} + \underset{(2.7)}{.405\, \mu^{fms}}$$
$$R^2 = .94;\ Dh = 1.3$$

[1]Values in parentheses are t-ratios, R^2 is the adjusted coefficient of variation, DW is the Durbin-Watson statistic, and Dh is the Durbin-h statistic.

expenditures using a four quarter, second-order polynomial distributed lag with both end point restrictions imposed.

In the wholesale per capita butter demand equation, the CPI for fats and oils was included as a proxy for the price of butter substitutes. Current generic butter advertising yielded better statistical results than the second-degree polynomial distributed lag specification, and was therefore used in the butter demand equation. It appears that consumers respond immediately to generic butter advertising and the impact of such advertising is short-lived. The adjusted R^2 for this equation was the lowest of all equations.[4]

[4] This is partially due to the existence of four outliers: quarter 2 of 1977, quarter 2 of 1980, and quarters 1 and 2 of 1989. When intercept dummy variables were used to account for these outliers, the adjusted R^2 increases to .61. However, since there is no theoretical justification for inclusion of these dummy variables, they were omitted.

Table 2. Variable Definitions and Data Sources for the Econometric Model

Endogenous Variables (in alphabetical order):

P^{fm} = farm milk price measured in \$/cwt., from Dairy Situation and Outlook,
P^{II} = Class II price for raw milk measured in \$/cwt., from Federal Milk Order Market Statistics,
P^{wf} = wholesale fluid milk price index (1982 = 100), from Producer Price Index (and Wholesale Price Index),
P^{wfz} = wholesale price index for frozen daily products (1982 = 100), from Producer Price Index (and Wholesale Price Index),
Q^{fms} = raw milk supply measured in bil. lbs., from Dairy Situation and Outlook,
Q^{gb} = government purchases of butter in bil. lbs. of milkfat equivalent (in identity, not behavioral equations), from Dairy Situation and Outlook,
Q^{gc} = government purchases of cheese in bil. lbs. of milkfat equivalent (in identity, not behavioral equations), from Dairy Situation and Outlook,
Q^{wbd} = wholesale butter demand measured in bil. lbs. of milkfat equivalent, computed as butter supply minus government purchases of butter minus change in commercial butter inventories (from Cold Storage),
Q^{wbs} = wholesale butter supply measured in bil. lbs. of milkfat equivalent (Q^{wbs} = Q^{wbd}), from Dairy Products Annual Summary,
Q^{wcd} = wholesale cheese demand measured in bil. lbs. of milkfat equivalent, computed as cheese supply minus government purchases of cheese minus change in commercial cheese inventories (from Cold Storage),
Q^{wcs} = wholesale cheese supply measured in bil. lbs. of milkfat equivalent, (Q^{wcs} = Q^{wcd}), from Dairy Products Annual Summary,
Q^{wf} = wholesale fluid milk quantity measured in bil. lbs. of milkfat equivalent (note that wholesale fluid demand is equal to supply, i.e., Q^{wfs} = Q^{wfd}), from Cox,
Q^{wfz} = wholesale frozen dairy product quantity measured in bil. lbs. of milkfat equivalent (note that wholesale frozen demand is equal to supply, i.e., Q^{wfzs} = Q^{wfzd}), from Dairy Products Annual Summary,

Exogenous Variables and Other Definitions (in alphabetical order):

COS_1 = harmonic seasonal variable representing the first wave of the cosine function,
COS_2 = harmonic seasonal variable representing the second wave of the cosine function,
CPI = Consumer price index for all items (1982–84 = 100),
d = Class I fixed price differential for raw milk measured in \$/cwt., computed as Class I price minus Class II price,
DGBAD = generic butter advertising expenditures deflated by the media price index, measured in thousand \$, from Blaylock,
DGCAD = generic cheese advertising expenditures deflated by the media price index, measured in thousand \$, from Blaylock,
DGFAD = generic fluid milk advertising expenditures deflated by the media price index, measured in thousand \$, from Blaylock,
Dh = Durbin-h statistic,
DTP = intercept dummy variable for the Dairy Termination Program equal to 1 for 1986.2 through 1987.3; equal to 0 otherwise,
DW = Durbin-Watson statistic,
INCOME = disposable personal income per capita, measured in thousand \$, from Employment and Earnings,
L = lag operator,
MDP = intercept dummy variable for the Milk Diversion Program equal to 1 for 1984.1 through 1985.2; equal to 0 otherwise,
MWAGE = average hourly wage in manufactured sector \$/hour, from Handbook of Basic Economic Statistics,
P^{bev} = Consumer retail price index for nonalcoholic beverages (1982–84 = 100), from Consumer Price Index,
P^{cow} = U.S. average slaughter cow price measured in \$/cwt., from Dairy Situation and Outlook,
P^{fat} = Consumer retail price index for fats and oils (1982–84 = 100), from Consumer Price Index,
P^{fe} = Producer price index for fuel and energy (1967 = 100), from Producer Price Index (and Wholesale Price Index),
P^{feed} = U.S. average price per ton of 16% protein dairy feed, from Dairy Situation and Outlook,
P^{fr} = U.S. index of prices received by farmers; from Agricultural Prices,
P^{gb} = government purchase price for butter measured in cents/lb., from Dairy Situation and Outlook,
P^{gc} = government purchase price for cheese measured in cents/lb., from Dairy Situation and Outlook,
P^{mea} = Consumer retail price index for meat (1982–84 = 100), from Consumer Price Index,
POP = U.S. population measured in millions, from Handbook of Basic Economic Statistics,
R^2 = adjusted coefficient of determination,
SIN_1 = harmonic seasonal variable representing the first wave of the sine function,
T = time trend variable for the retail and wholesale-level equations, equal to 1 for 1975. 1, . . . ,
μ^i = error term for equation i.

In the wholesale fluid milk supply equation, the Class I milk price represents the most important variable cost to fluid processors. The producer price index for fuel and energy was used as a proxy for variable energy costs. The inclusion of lagged endogenous variables represents capacity constraints, while the cosine variable captures seasonality in the fluid milk supply. A first-order autoregressive error structure was specified to correct for autocorrelation.

In the wholesale frozen product supply equation, the Class II price was included because it represents the most important variable cost to frozen product manufacturers. The lagged endogenous variables were incorporated as capacity constraints on frozen product supply. The time trend was a proxy for technological change in frozen product manufacturing, and the sine and cosine variables capture seasonality in supply. Based on the autocorrelation and partial autocorrelation functions, a first-order moving average error structure was imposed.

In the wholesale cheese supply equation, the Class II price was included since it is the most important variable cost to cheese processors. The average manufacturing wage rate was a proxy for labor costs. The time trend was a proxy for technological change in cheese processing, and the intercept dummy variable corresponding to the quarters the 1986–87 DTP was in effect was included to capture its impact on reducing the milk supply. The cosine variable measures the seasonality in cheese supply. A first-order moving average error structure was specified to correct for autocorrelation.

In the wholesale butter supply equation, the Class II price was included since it is the most important variable cost to butter processors. Butter supply lagged one quarter was a proxy for capacity constraints in butter manufacturing. The time trend was a proxy for technological change in butter processing, and the intercept dummy variables for the two supply control programs measure the effects they had on reducing milk availability for butter. The sine and cosine variables capture the seasonality in butter supply.

For the farm milk market, the milk supply equation includes the price of 16% protein feed because it is one of the most important variable costs to dairy farmers. The deflated price of slaughter cows was a proxy for opportunity costs of milk production. Lagged milk supply was included to reflect biological capacity constraints for current milk production, while the time trend measures technological progress in dairy farming. The two intercept dummy variables capture the reduction in milk supply that occurred during the MDP and DTP, and the cosine variable measures seasonality in milk production. A moving average error structure was imposed to correct for autocorrelation.

Model Validation

The model was dynamically simulated to assess its ability to replicate historical values for the endogenous variables. The time period chosen for this dynamic in-sample simulation was from the first quarter of 1980 (i.e., 1980.1) through the fourth quarter of 1990 (i.e., 1990.4). This period was also the period used for the simulation and was chosen because it corresponds to a time when there was much discussion of implementing alternative dairy policies.

To conduct the dynamic simulation, all exogenous variables were set equal to their historic levels for the simulation period. For the first quarter in the simulation, all lagged dependent variables were set equal to their actual levels for the previous period and the system of equations was solved simultaneously using the Newton method. For all subsequent quarters in the simulation, the predicted endogenous variables become the lagged endogenous variables in the model. This process was repeated until the last period of the simulation was reached.

Table 3 shows the root-mean-square-percent

Table 3. Quarterly Averages for Actual and Simulated Endogenous Variables from the Dynamic Simulation and Root-Mean-Square Percent Errors

Endogenous Variable	Unit	Actual Average	Simulated Average	Root-Mean-Square Percent-Error
Fluid milk demand	bil lbs	13.04	13.07	0.93
Frozen product demand	bil lbs	3.20	3.21	2.54
Cheese demand	bil lbs	8.93	8.84	8.81
Cheese supply	bil lbs	9.72	9.56	5.05
Butter demand	bil lbs	4.69	4.62	11.60
Butter supply	bil lbs	6.38	6.53	8.44
Wholesale fluid milk price	1982 = 100	104.28	99.93	11.17
Wholesale frozen price	1982 = 100	106.36	102.13	7.05
Class II price	$/cwt	11.94	11.32	14.44
Farm milk supply	bil lbs	34.95	34.96	2.01
Farm milk price	$/cwt	13.10	12.26	13.39
CCC cheese	bil lbs	0.82	0.75	68.39
CCC butter	bil lbs	1.69	1.90	44.41

simulation error (RMSPE), as well as the actual and simulated average values for all of the endogenous variables in the model. Generally, the RMSPEs for the supply and demand quantities are reasonable, given the rigor of a dynamic simulation test. All wholesale and farm supply and demand quantities have RMSPEs under 11.6%. With respect to prices, the RMSPEs are somewhat higher, ranging from a low of 7.1% for the wholesale frozen product price to a high of 14.4% for the Class II price. Finally, the RMSPEs for CCC cheese and butter purchases are 68.4% and 44.4%, respectively. While these may appear high, due to the small magnitude of these variables, a small deviation from the actual value leads to a large RMSPE. Based on overall performance, the simulation model was deemed reasonable for the purpose of comparing policy scenarios.

Government Dairy Policy Scenarios

The six policy scenarios considered were: (1) current program (baseline), (2) immediate deregulation by immediate elimination of the DPSP, (3) gradual deregulation by lowering the government purchase prices for cheese and butter by 10% per year over the simulation period, (4) target price-deficiency payment program without supply control, (5) target price-deficiency payment program with supply control, and (6) mandatory supply control program. For each scenario, it was assumed that the policy was in effect for the period 1980.1 through 1990.4.

In the baseline policy scenario, the government purchase prices for cheese and butter were set equal to their actual levels for this period. Also, the dummy variables for the two voluntary supply control programs (MDP and DTP) were included in the equations to reflect the impact of these programs on milk and dairy product supplies. For the other policy scenarios, the dummy variables for the MDP and DTP were set equal to zero for all quarters. The baseline represents the historical simulation of actual policy (the same as the in-sample simulation conducted to validate the model) to which the alternative policy simulations are compared.

The immediate deregulation scenario assumed that the DPSP was removed at the beginning of 1980. In this case, the model was modified by setting the purchase prices for cheese and butter to zero and forcing the competitive market to clear and determine equilibrium prices for all products including cheese and butter.

Because it is unlikely that the government would eliminate the DPSP immediately, a gradual phase out scenario was included. Under this scenario, the CCC continued cheese and butter purchases, but the purchase price for each product was reduced by 10% each year after 1980. Gradual deregulation is not as disruptive to the wholesale and farm markets, and would likely be more politically acceptable than immediate elimination of the price support program. As in the immediate deregulation scenario, the model was solved allowing the competive market to determine equilibrium prices for all products. However, if the resulting wholesale market price for cheese (or butter) was lower than its purchase price, then the wholesale price was set equal to the purchase price and the system of equations was solved again. This insured that the wholesale prices for cheese and butter were always at least as high as their purchase prices.

The target price-deficiency payment program scenario assumed that the DPSP was replaced by a $13.00 per hundredweight target price for farm milk. The model was modified by adding the following requirement: if the simulated farm milk price for any quarter was below $13.00 per hundredweight, than a deficiency payment was added to the milk price and the model was solved again for that quarter treating the $13.00 farm milk price as exogenous. If the farm milk price for any quarter was at or above $13.00 per hundredweight, no deficiency payment was made.

A target price-deficiency payment program could incur large government costs. Thus, a second scenario was added in which for any quarter that total deficiency payments exceeded $310 million (simulated quarterly average government costs for the baseline-actual policy scenario), a supply control program was triggered and required farmers to reduce milk marketings to a point where government costs no longer exceeded $310 million.[5] This policy reduced government costs by: (1) reducing the quantity of milk deficiency payments were paid on, and (2) reducing the quantity supplied, thus raising the market price and lowering the deficiency payment rate.

In the supply control scenario, it was assumed that the DPSP was eliminated and a $13.00 per hundredweight price was achieved by restricting the milk supply. It was assumed that the government's ability to control supply is perfect, which is

[5] This feature was incorporated into the model by reducing farm milk supply in increments of 10 million pounds and re-solving the model. This process was repeated until the government cost restriction was satisfied. By using such a small increment to reduce supply in each iteration (10 million pounds out of a national supply averaging 35 billion pounds per quarter), greater accuracy could be achieved in converging to the mandated level of government costs.

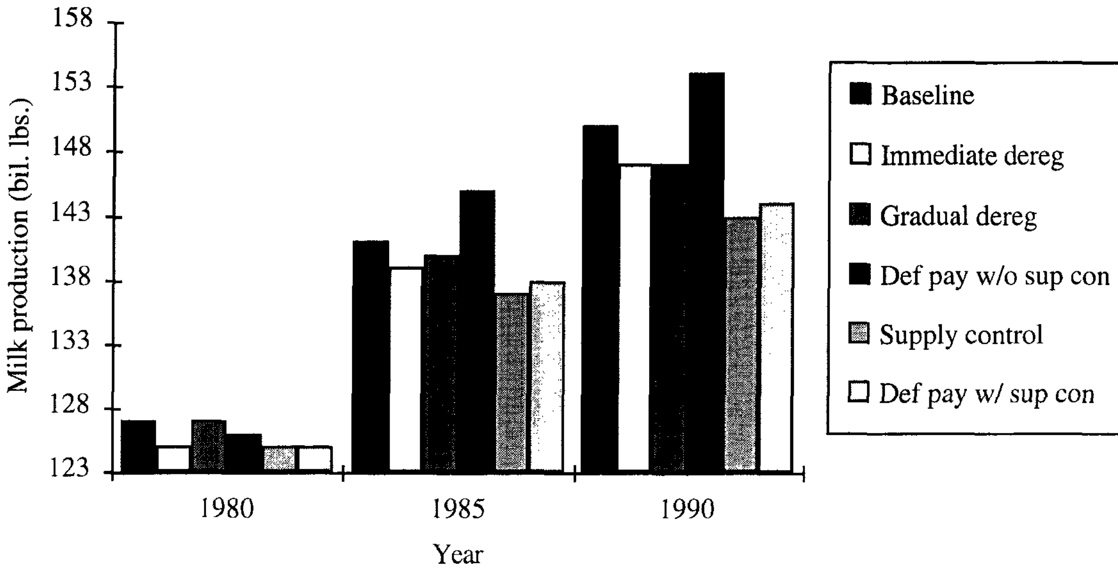

Figure 1. Impact of alternative dairy policies on milk production for selected years, 1980–90.

a reasonable assumption since the government could set a zero price for over-quota milk marketings. Under this type of program, the government would estimate commercial demand as well as the level of milk supply needed to generate an equilibrium price of $13.00. Once the proper level of national supply is determined, then production or marketing quotas are allocated to farmers. Farmers' quotas would likely be based on historical production over some designated time period. It was assumed that farmers receive $13.00 per hundredweight for all milk sold within quota, and zero for milk sold over-quota.[6] This alternative is similar to the target price-deficiency payment program with supply control, but with no deficiency payments consumer prices are higher and supply is slightly lower.

Results

Equilibrium quantities and prices for each scenario were simulated over the time period 1980.1 through 1990.4. The results of the six policy scenarios are presented in Table 4, which reports the baseline results and the percentage change in the quarterly average quantities and prices from the baseline scenario. Market variables are shown graphically for 1980, 1985, and 1990 in Figures 1–5.

In the farm market, the milk supply consistently increased from 1980 to 1990 under all six scenarios due to increases in cow productivity, as shown in Figure 1. The milk supply was the lowest under the supply control alternative. To receive the benefit of a $13.00 per hundredweight minimum price, farmers would have to reduce milk marketings by about 3.2%. The milk supply was the highest under the target price-deficiency payment without supply control alternative (hereafter referred as the first target price-deficiency payment alternative) because the effective farm milk price (market price plus deficiency payment) was higher than for the other policies that do not restrict supply. On the other hand, the milk supply was lower, on average, than the baseline under the target price-deficiency payment program with supply control (hereafter called the second target price-deficiency payment alternative). To contain government expenditures under this program, farm milk supply had to be lower than the baseline. The milk supply under the two deregulation scenarios was quite comparable. As shown in Figure 1, the milk supply was almost the same for both deregulation scenarios after 1985.

The farm milk price was highest under the supply control policy. The milk price was very stable in this scenario, averaging $13.06 per hundredweight (Figure 2). The farm milk price was similar under both target price-deficiency payment pro-

[6] If the simulated farm milk price for any quarter was less than $13.00 per hundredweight, then 10 million pounds of milk were subtracted from the milk supply and the model was re-solved given the new milk supply level. This iterative procedure of reducing the milk supply in 10 million pound increments was continued until the farm milk price reached $13.00 or more. Again, by using such a small increment to reduce supply in each iteration, greater accuracy could be achieved in converging to an equilibrium price close to $13.00 per hundredweight.

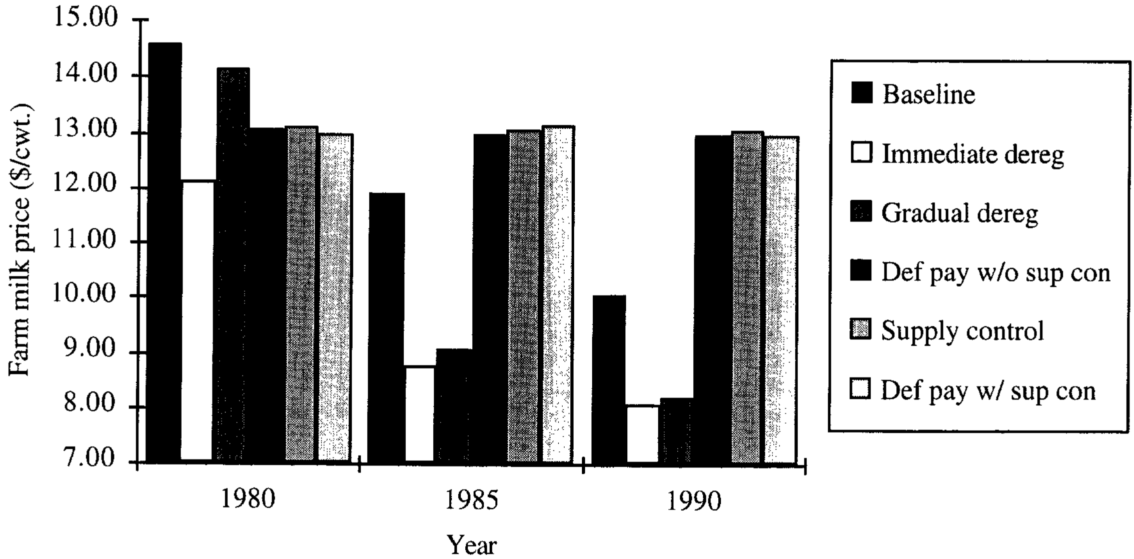

Figure 2. Impact of alternative dairy policies on farm milk prices for selected years, 1980–90.

grams. The farm price was the lowest in the immediate deregulation scenario. The farm price was also lower under the gradual deregulation scenario. After 1983, the farm milk price was quite similar between the two deregulation scenarios. Interestingly, there was more price instability under gradual deregulation than there was under immediate deregulation; the gradual deregulation policy had a coefficient of variation for the farm price of 19.0%. Most of this volatility occurred at the beginning of the simulation when the market was adjusting to the new policy. The supply control program was at the other extreme in terms of farm price variability with a coefficient of variation of 0.3%. The baseline, immediate deregulation, and first and second target price-deficiency payment policies had coefficient of variations for the farm price of 12.1%, 17.5%, 0.4%, and 0.8%, respectively.

Regarding farm welfare, there was a positive trend in producer surplus over time under the two target price-deficiency payment programs and supply control alternatives (Figure 3). Farmers were best off under the first target price-deficiency payment policy. Farmers were also better off under the second target price-deficiency payment program

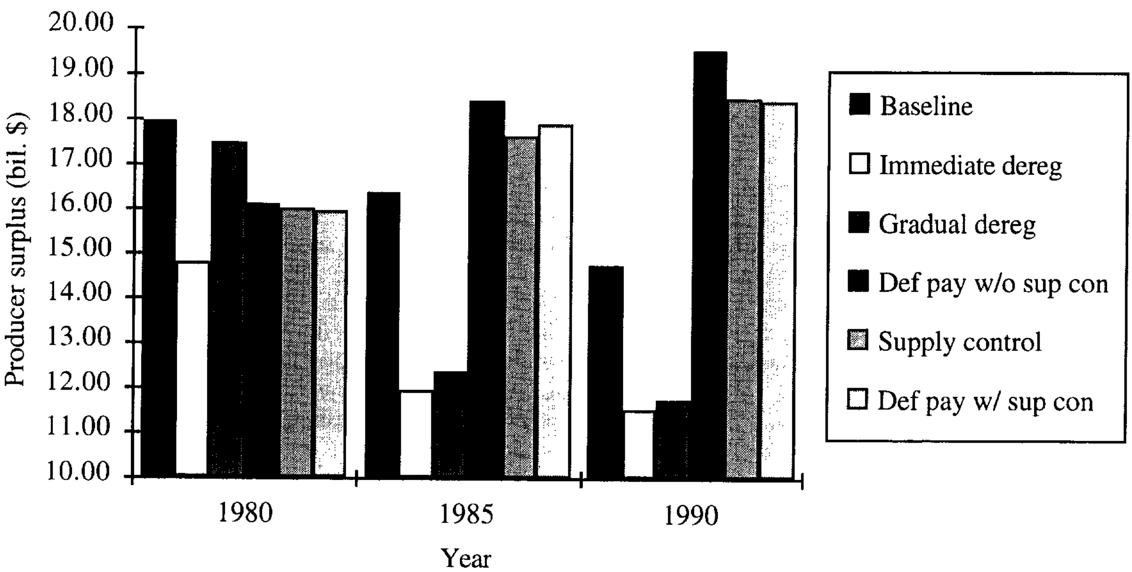

Figure 3. Impact of alternative dairy policies on producer surplus for selected years, 1980–90.

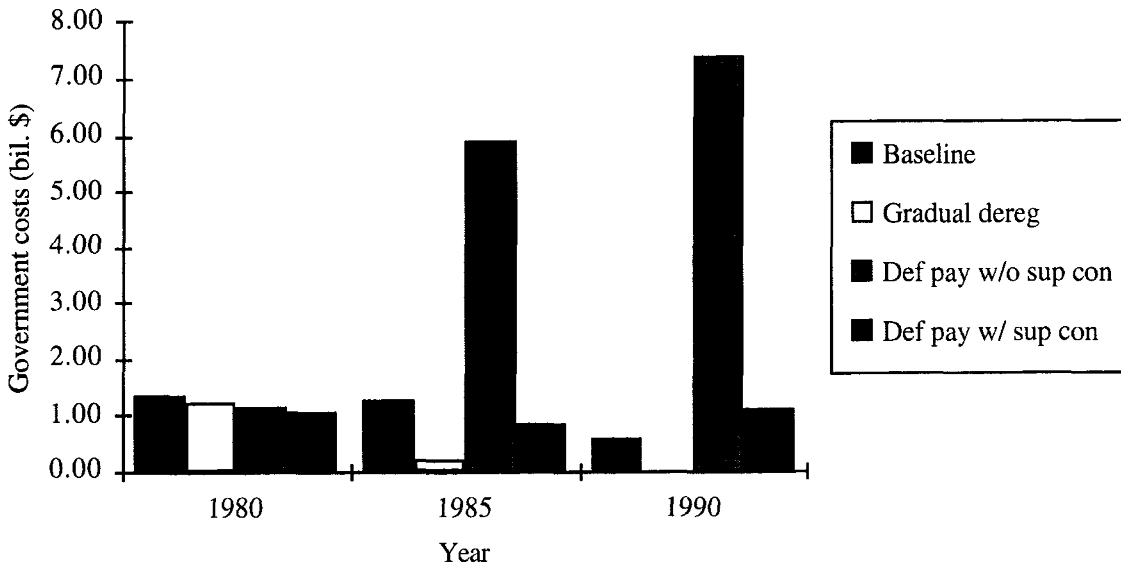

Figure 4. Impact of alternative dairy policies on direct costs of dairy price support program for selected years, 1980–90.

and the supply control program. Farmers were better off with the first target price-deficiency payment program relative to the supply control alternatives. Prices received were comparable for the programs, but supply was not restricted under the first target price-deficiency payment program. In the two deregulation scenarios, there was a negative trend in producer surplus over time (Figure 3). Dairy farmers were worse off, as a group, under both deregulation scenarios. These results suggest that producers, as a group, would favor supply control and both target price-deficiency payment programs over the current price support program, but would definitely not favor deregulation over the current policy.

Government costs under the baseline and the gradual deregulation scenarios were calculated as the product of the purchase price for cheese (converted to a dollars per hundredweight of raw milk basis) times total CCC purchases of cheese and butter on a milkfat equivalent basis.[7] Government cost for the two deficiency payment programs was computed as the product of the deficiency payment (dollars per hundredweight) times the farm milk supply. There were no government costs for the immediate deregulation or the supply control scenarios.

The simulations indicated that the first target price-deficiency payment program was the most expensive for the government (Table 4 and Figure 4). Government costs for this program averaged $1.3 billion per quarter, which is 316% higher than the $310 million per quarter that the baseline policy costs. This policy, therefore, would obviously be at a disadvantage from a political standpoint, given current federal budget deficit pressures. However, when supply control was added to the second target price-deficiency payment program, government costs were actually lower by almost 20%, on average, than the baseline. Hence, with standby supply control, target price-deficiency payment programs can be designed to not incur excessive government costs. Gradual deregulation would also save the tax payers money relative to the baseline. Purchases of cheese and butter by the CCC under the gradual deregulation scenario were 81.3% and 60.6% lower, respectively, than they were under the baseline. Government costs in this case were 71.0% lower, on average, and declined over time. If the government had started to decrease purchase prices in 1981, government purchases and costs of the DPSP would not have increased as they did, but would have actually decreased. The best policies in terms of reducing government costs were the immediate deregulation and supply control policies, which had no associated government costs. Given current Federal deficits, these options could attract some interest.

[7] The purchase price for butter is not used here because butter is jointly produced with nonfat dry milk, and one needs nonfat dry milk purchases to convert these two products to a milk equivalent basis. Since nonfat dry milk is not included in the model, one cannot compute the milk equivalent purchase price for butter and nonfat dry milk. The use of the cheese purchase price only to measure monetary costs to the CCC is reasonable since all purchase prices are quite close when converted to a milk equivalent measure.

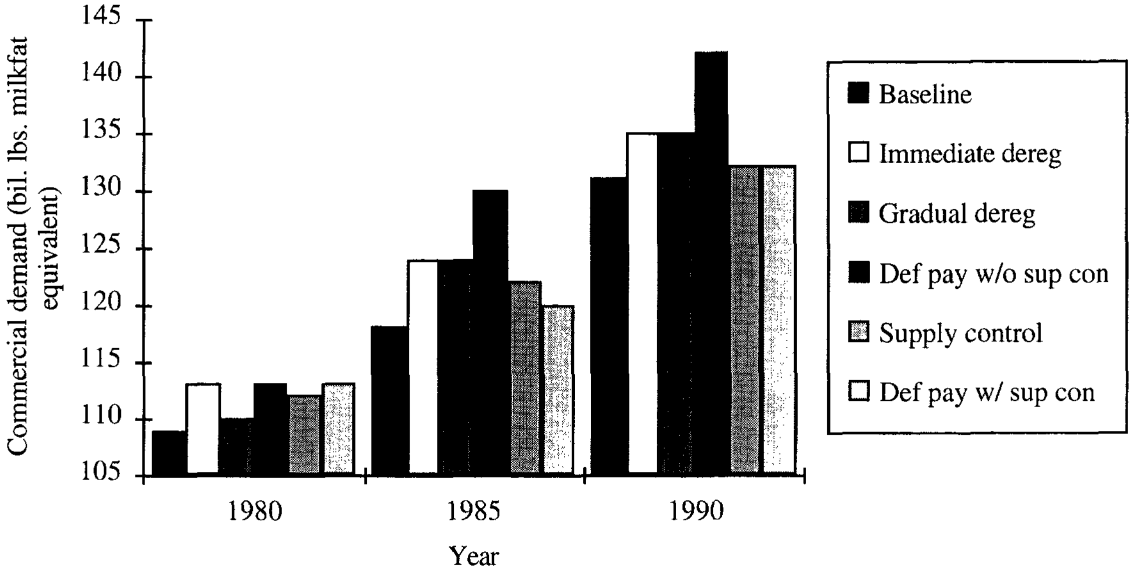

Figure 5. Impact of alternative dairy policies on commercial disappearance of dairy products for selected years, 1980–90.

Regarding the wholesale market, commercial demand for all alternatives was higher than the baseline policy. Commercial demand for all products was highest under the first target price-deficiency payment program. This was due to the average wholesale prices for all four products being substantially lower for this alternative than for the other alternatives (see Table 4). Commercial wholesale demand was higher under the two deregulation scenarios compared to the baseline. This was due to the wholesale prices for all products being lower under deregulation relative to the baseline. Commercial demand was higher in the second target price-deficiency payment scenario than the baseline, which was again due to lower wholesale prices (except for frozen products). While fluid milk and frozen product demand was lower in the supply control scenario than in the baseline, cheese and butter demand was actually higher. This seemingly counter-intuitive result is explained by lower wholesale cheese and butter prices (9% and 24.2% lower than the baseline) with no support program. The net effect was commercial disappearance being 2.4% higher, on average, under the supply control program than the baseline. It should also be noted that while cheese and butter commercial use increased under supply control relative to the baseline, cheese and butter supplies actually decreased by 1.7% and 14.2%, respectively. These supply responses were due to the loss in sales to the government since the price support program was terminated under this scenario.

Extrapolating the wholesale results to the retail level, it appears that consumers would favor the first target price-deficiency payment program over all other policies because it resulted in the lowest prices. Wholesale prices for all products were substantially lower for this alternative than all other policies. In this case, the wholesale fluid milk price was 45.0% lower, the wholesale frozen product price was 32.4% lower, the wholesale cheese price was 2.2% lower, and the wholesale butter price was 60.4% lower than the baseline on average. However, the tremendous magnitude of price advantage of this program for consumers would likely be offset by the corresponding tax burden required to pay for the program. Since consumers are also tax payers, they would obviously find this an unattractive aspect of the first target price-deficiency payment program. Consumers were better off under the immediate and gradual deregulation scenarios. Regarding immediate deregulation, wholesale fluid milk, frozen product, cheese, and butter prices averaged 18.2%, 10.7%, 6.9%, and 39.4% lower than in the baseline. All wholesale prices for gradual deregulation were also lower than the baseline, but slightly higher than the immediate deregulation case (see Table 4). With the exception of the wholesale frozen price, which was 0.2% higher, all other wholesale prices were slightly lower under the second target price-deficiency payment program than the baseline. While wholesale fluid milk and frozen product prices were slightly higher than the baseline, on average, under supply control, wholesale butter and cheese prices were 8.3% and 20.7% lower.

Table 4. Selected Market Variables Under the Five Daily Policy Alternatives as a Percent of the Baseline Values

Market Variable	Unit	Baseline (quarterly average)	Immediate Deregulation (% change)	Gradual Deregulation (% change)	Target Price-Def Payment Without Supply Control (% change)	Target Price-Def Payment with Supply Control (% change)	Supply Control (% change)
Fluid milk demand	bil lbs	13.07	0.82	0.65	2.57	0.01	−0.20
Frozen product demand	bil lbs	3.21	1.85	1.46	6.93	0.19	−0.46
Cheese demand	bil lbs	8.84	2.58	2.05	0.77	2.86	3.47
Cheese supply	bil lbs	9.56	−2.53	−1.93	−4.20	−1.64	−1.71
Butter demand	bil lbs	4.62	18.89	14.42	40.28	9.84	9.94
Butter supply	bil lbs	6.53	−7.87	−5.09	7.27	−11.17	−14.20
Wholesale fluid milk price	1982 = 100	99.93	−18.22	−14.67	−45.03	−0.01	4.92
Wholesale frozen price	1982 = 100	102.13	−10.68	−8.63	−32.40	0.17	2.96
Wholesale cheese price	cents/lb	1.28	−6.92	−5.58	−2.22	−7.37	−9.07
Wholesale butter price	cents/lb	1.37	−39.39	−31.60	−60.36	−25.24	−24.19
Class II price	$/cwt	11.32	−25.66	−20.42	−60.48	−0.82	6.83
Farm milk supply	bil lbs	34.96	−1.68	−1.10	1.81	−2.51	−3.24
Farm milk price	$/cwt	12.26	−23.48	−18.71	6.12	6.26	6.57
CCC cheese[1]	bil lbs	0.75	NA	−81.29	NA	NA	NA
CCC butter[1]	bil lbs	1.90	NA	−60.58	NA	NA	NA
Producer surplus	bil $	4.17	−25.02	−20.03	8.51	4.63	4.23
Government cost[2]	bil $	0.31	NA	−70.97	316.13	−19.35	NA
Deficiency payment[3]	$/cwt	NA	NA	NA	3.66	0.75	NA

[1]In the immediate deregulation, target price-deficiency payment, and supply control scenarios, there are no CCC purchases.
[2]Government costs for the baseline and gradual deregulation scenarios are calculated as the product of the purchase price for cheese on a milkfat equivalent basis, times total CCC purchases of cheese and butter on a milkfat equivalent basis. Government costs of the target price-deficiency payment scenarios are calculated as the product of the deficiency payment times milk supply. There are no government costs for the immediate deregulation and supply control scenarios.
[3]The number for the target price-deficiency payment scenarios is the actual average payment on a $/cwt. basis rather than a percentage change basis.

The results indicate that there is a trade-off among some of the policies in terms of consumer welfare and government costs. For instance, as was mentioned above, the deficiency payment program without supply control resulted in the lowest wholesale prices, but also had the highest government costs. This trade-off was also observed for the supply control program, which resulted in the lowest direct costs to the government, but also had the highest fluid and frozen product prices.

Summary

The purchase of this paper was to examine the potential market impacts of alternative dairy policy alternatives. The policies analyzed were: (1) a baseline price support program (present policy), (2) immediate deregulation where the price support program is eliminated, (3) gradual deregulation where the support prices for dairy products are decreased by 10% per year, (4) a target price-deficiency payment program without supply control, (5) a target price-deficiency payment program with supply control, and (6) a mandatory supply control program. A model of the national dairy industry was used to simulate quarterly equilibrium price and quantity values at the farm and wholesale levels for each policy over the period 1980–90.

The results indicated that there are gainers and losers for each policy option. Consumers were better off under both immediate and gradual deregulation because prices were lower, enabling them to consume more dairy products. Consumers were also better off under the two target price-deficiency payment programs due to lower prices. Consumers of fluid milk and frozen products were worse off under supply control since wholesale prices were at their highest under this alternative. However, wholesale cheese and butter prices were actually lower with supply control than under the baseline due to the elimination of the DPSP. Consequently, consumers of cheese and butter were better off under supply control than under current policy. Farmers, as a group, were better off under the two target price-deficiency payment programs and the supply control program, where milk prices and producer surplus were highest. Farmers suffered the most in the immediate deregulation scenario where both the farm price and producer surplus were at their lowest. Tax payers were best off under immediate deregulation, supply control, and the target price-deficiency payment program with supply control. They were worse off under the target price-deficiency payment program without supply control. Tax payers were also better off under gradual deregulation. These results suggest that the relative political weight of consumers, farmers, and tax payers in the minds of policy makers will be important in shaping future dairy policy legislation.

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