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A USER'S GUIDE TO NEMPIS:

NATIONAL ECONOMIC MILK POLICY IMPACT SIMULATOR

by

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PREFACE

Harry M. Kaiser is an Assistant Professor in the Department of Agricultural Economics at Cornell University. The useful comments by Loren Tauer are gratefully acknowledged. This research was funded by Federal Hatch Project 522.

This paper describes a computer program designed to simulate farm and retail market impacts of various dairy policies and technologies. This software, which is called National Economic Milk Policy Impact Simulator (NEMPIS), simulates annual equilibrium prices and quantities at the farm and retail level for the dairy market from 1990 up to and including 2008. To illustrate the type of output generated by NEMPIS, several scenarios involving plausible policy and technology assumptions are solved.

This software is free to anyone. To obtain a copy of the program, send the author your name, address, and an IBM compatible 5.25 inch formatted floppy disk. The author's address is:

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Federal dairy policy in the United States fundamentally changed in 1985 with the enactment of the five-year Food Security Act (FSA). Probably the most profound change had to do with how the annual level of the milk support price was to be determined. Breaking with previous policy, the FSA mandated that support price adjustments would be based on the level of dairy surpluses bought by the government. Specifically, the 1985 Act required the Secretary of Agriculture to forecast government purchases of dairy products prior to each calendar year. If projected purchases were over five billion pounds (on a butterfat milk equivalent basis), then the support price was decreased by $0.50 per hundredweight for the upcoming year according to this legislation. On the other hand, the support price was to be increased by $0.50 per hundredweight if government purchases are predicted to be less than 2.5 billion pounds.

The Food Security Act also authorized the Secretary of Agriculture to implement a voluntary supply control program to reduce production in excess of commercial needs. This option, formally called the Dairy Termination Program, invited dairy farmers to dispose of their cattle and remain out of dairying for five years in return for government

payments. The government removed over one million dairy cattle representing over 12 billion pounds of milk production (in 1985) through this program (Kaiser and Novakovic).

The FSA will expire at the end of 1990 and Congress is currently in the process of designing another omnibus Farm Bill to guide policy for the first half of the 1990's. Most political observers agree that federal budget limitations will heavily affect the provisions of the next Farm Bill. Most would also agree that some of the dairy provisions of the previous FSA have been viewed quite favorably by Congress, as well as by the President. Hence, it is conceivable that future dairy policy will not deviate dramatically from the policy initiated in 1985.

With that in mind, the purpose of this paper is to document and describe a computer program which simulates the impact of alternative FSA-type policies and technologies on important dairy market variables such as farm and retail prices and quantities. Several policy and technology scenarios are simulated to illustrate the output of the program. The model, which is called the National Economic Milk Policy Impact Simulator (NEMPIS), is general in specifications of the duration of the simulation period, policy instruments, and technological choices. The computer software is available to anyone, provided that they send the author a standard 5.25 inch IBM compatible formatted floppy disk. The model should be of interest to economists, policy

makers, and dairy scientists interested in analyzing farm and retail market impacts due to federal policies and/or alternative technologies.

AN OVERVIEW OF NEMPIS

NEMPIS is an annual model of the national dairy industry for policy and technology simulations. The computer program has been compiled using Microsoft QuickBASIC programming language and will run on any IBM or IBM compatible personal computer with at least 128K of random access memory (RAM).

The structure of NEMPIS is similar to a national dairy model developed by Kaiser, Streeter, and Liu. It is assumed that the national dairy market consists of an aggregate farm sector and an aggregate retail sector. Within this framework, dairy farmers produce and sell raw milk to retailers of dairy products. The retail market is sub-divided into two groups based on the type of products being processed and sold. Class 1 (fluid products) retailers process and sell fluid products directly to consumers, and Class 2 (manufactured products) retailers process and sell manufactured dairy products directly to consumers. Additionally, the two major federal programs which regulate the dairy industry, the federal dairy price support and federal milk marketing order programs, are assumed to be in affect.

Under the dairy price support program, the government supports the price of manufactured grade milk by agreeing to buy unlimited quantities of storable dairy products at specified purchase (support) prices. By increasing the farm demand for milk, the government thereby indirectly supports the price of raw milk. Federal milk marketing orders regulate handlers of milk eligible for fluid markets. The basic thrust of federal orders is to institute a classified system of milk pricing, where handlers of milk used for fluid purposes pay a higher price (Class 1 price) than handlers of manufactured grade milk, who pay Class 2 or Class 3 prices. Farmers receive an average of the class prices, weighted by the fluid and non-fluid utilization rates in the marketing area.

Figure 1 displays a flow chart illustrating the basic logic of NEMPIS.[1] The simulation period begins in 1990 and the user may specify any ending date up to and including the year 2008. There are two milk production technology options available in NEMPIS.[2] The first assumes that bovine somatotropin (bST) is not available during the entire simu-

[1] There are two versions of NEMPIS. NEMPIS1.EXE should be used on personal computers that do not have color monitors. NEMPIS2.EXE should be used on personal computers that have color monitors. Both versions are identical except for this distinction. To run the program, the user should type "NEMPIS."

[2] Actually, other new farm technologies besides bovine somatotropin can be simulated with NEMPIS. Bovine somatotropin is used simply because it is the most likely new technology that will be commercially available soon.
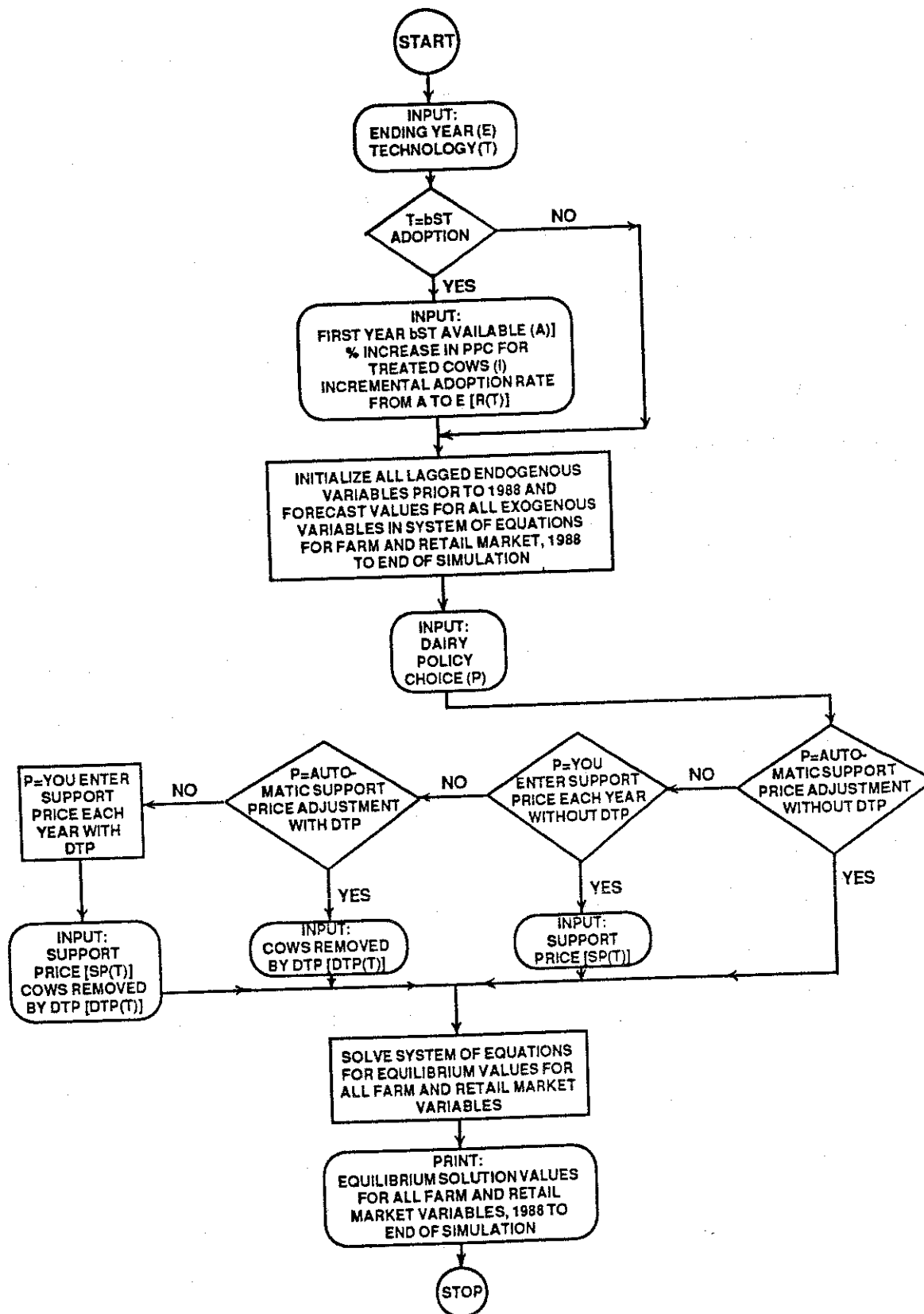
Figure 1. Flow Chart of NEMPIS.

lation period. Under this technology, increases in production per cow are assumed to be due to non-bST technological advances, increases in the milk price, and/or decreases in variable costs of production. The second option assumes that bST will be available for part or all of the simulation period. By choosing this option, the following additional information must be specified: (1) the first year that bST is commercially available, (2) the national average increase in production per cow for cows treated with bST, and (3) the incremental adoption rates, by year, from when bST is available to the end of the simulation period.[3] Under this technology, increases in production per cow are assumed to be due to bST as well as non-bST technological advances, increases in the milk price, and/or decreases in variable costs of production.

Once the ending year and technology choice has been selected, the program initializes all predetermined (lagged endogenous) variables and forecast all exogenous variables used to solve the system of equations. Most of the exogenous variables in the supply and demand equations are forecasted using lagged dependent variables and a time trend as explanatory variables. The endogenous variables in the supply equations are also estimated as functions of lagged

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[3] The term "incremental adoption rate" here refers to the additional percentage of farmers who adopt bST each year. For example, if 5% of U.S. dairy farmers adopt bST in 1990, and an additional 20% adopt it in 1991, then one would enter 5% for 1990 and 20% for 1991. The program automatically calculates the cumulative adoption rate from the inputted incremental rates.

dependent variables. Consequently, previously observed (pre-1990) values for these variables are initialized by the program.

The final piece of information required is the choice of federal dairy policy to be in affect for the simulation period. There are four general categories of policy offered by this program: (1) automatic support price adjustments without a Dairy Termination Program (DTP), (2) user specified support prices without a DTP, (3) automatic support price adjustments with a Dairy Termination Program, and (4) user specified support prices with a DTP.

If one selects the first option of automatic support price adjustments without a DTP, the program automatically determines the support price, as well as all equilibrium quantities and prices. The support price is determined by an iterative process according to the support price adjustment rule established under the Food Security Act, which is based on levels of dairy product purchases by the Commodity Credit Corporation (CCC). Each iteration consists of solving the system using the previous year's support price. If CCC purchases are determined to be above five billion pounds, then the equilibrium values are re-computed for that year by re-solving the system using a support price that is $0.50 per hundredweight lower than the previous year. Alternatively, if simulated CCC purchases are less than 2.5 billion pounds, then the equilibrium values are re-

computed by adding $0.50 per hundredweight to the support price.

The second policy option allows the user to specify the support price for each year and assumes that there is no DTP. If this choice is selected, then NEMPIS will prompt the user to input the 3.67% butterfat support price per hundredweight for 1990 through the end of the simulation. In this case, the system of equations is solved using the specified support price for each year in the simulation.

The third policy option is identical to the first, except that it allows for government removal of cows via a DTP. Under this option, the support price is determined automatically by NEMPIS, but the user is prompted to input the number of cows (in thousands) the government will remove each year under a DTP.

The fourth option is the same as option 2, except that it allows for a DTP. If this option is chosen, the user will must provide both the support price and the number of cows enrolled in the DTP for each year of the simulation period.

If either of the two options allowing for a Dairy Termination Program are chosen, the user must recognize that the model assumes that the number of DTP cows specified are all disposed of on January 1 of each year. This is important to note because a cow removed from production in January has a larger impact on reducing annual milk production than a cow removed in August of the same year.

Once the policy choice has been provided by the user, NEMPIS solves the system of equations defining the national dairy market for all endogenous variables and annual equilibrium values are displayed on the screen. The farm level output consists of equilibrium values for cow numbers (COWS), pounds of production per cow (PPC), raw milk production (PROD), and the national 3.67% butterfat average milk price (AMP). The retail sector output includes quantities of Class 1 (Q1) and Class 2 (Q2) commercial sales on a milk equivalent butterfat basis, the retail fluid (RFP) and manufactured (RMP) price index, the Class 1 (P^I) and Class 2 (P^{II}) price, and total commercial demand for Class 1 and Class 2 products (TOTDEM). Finally, the government policy variables are the 3.67% butterfat support price (SP), number of cows removed under the Dairy Termination Program (DTP), and government purchases of dairy products on a milk equivalent butterfat basis (CCC).

METHODOLOGY

This section describes analytical procedures used to construct NEMPIS. The structure of NEMPIS consists of an econometric model of the national dairy industry and a set of simulation procedures based on the estimated equations. Each are discussed separately below.

The Econometric Model

The econometric model uses national annual time series data (1960 through 1989) on retail and farm market variables to estimate supply and demand functions for the U.S. dairy market. To simplify the estimation of the model, it is assumed that farmers have naive price expectations. That is, farmers expect the price in period t+1 to be the price in period t. This assumption, which is often used in dairy models (e.g., LaFrance and de Gorter; Chavas and Klemme; Liu, et al.), allows the farm supply to be estimated independently from the retail market as the milk price is exogenous. Table 1 presents the econometric results for the estimated equations and Table 2 defines all variables used in the model.

The two estimated equations in the farm market are cow numbers and production per cow. The cow number equation (CN) is estimated using ordinary least squares (OLS) as a function of cow numbers in the previous period, real average milk price lagged one year (P^m_{-1}), real dairy feed costs (FC), and a policy dummy variable (DTP) corresponding to the years that the Dairy Termination Program was in affect.[4] The use of cow numbers in the previous year reflects capacity constraints on the national dairy herd, dairy feed costs correspond to the major variable cost face by dairy farmers, and the policy dummy variable captures the signifi-

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[4] The term "real" used throughout this paper means that the nominal measure was deflated by the Consumer Price Index for all items (1967 = 100).

Table 1. The Econometric Equations for the Farm and Retail Markets.[*]

Cow Numbers Equation

$$\ln CN = 0.9896 \ln CN_{-1} + 0.0617 \ln P^m_{-1} - 0.0760 \ln FC + - 0.0391 \, DTP + 1/(1 + 0.7073 \, L) \, u$$
$$\quad\quad (76.7) \quad\quad\quad (1.3) \quad\quad\quad (-2.4) \quad\quad\quad (-3.7) \quad\quad\quad (4.7)$$

$R^2 = 0.99;\ DW = 1.97$

Production Per Cow Equation

$$\ln PPC = 2.4482 + 0.7254 \ln PPC_{-1} + 0.0592 \ln P^m_{-1} - 0.0582 \ln FC + 0.0054 \, T + u$$
$$\quad (2.5) \quad (6.8) \quad\quad\quad (1.9) \quad\quad\quad (-2.3) \quad\quad\quad (2.1)$$

$R^2 = 0.99;\ DW = 2.30$

Retail Fluid Price Instrument

$$P^f = 8.4176 \, SP + 12.2101 \, W + 1/(1 + 0.9524 \, L) \, u$$
$$\quad (4.0) \quad\quad (4.3) \quad\quad\quad (17.7)$$

$R^2 = 0.99;\ DW = 2.23$

Fluid Demand Equation

$$\ln Q^{fd}/POP = - 1.0246 - 0.4756 \ln \hat{P}^f + 0.0653 \ln P^b + 0.4562 \ln Y - 0.9811 \ln A_2 - 0.0315 \, T + u$$
$$\quad\quad (-3.0) \quad (-3.4) \quad\quad (1.7) \quad\quad\quad (3.6) \quad\quad\quad (-2.4) \quad\quad\quad (-12.0)$$

$R^2 = 0.99;\ DW = 1.48$

Class I Milk Price Equation

$$P^I = 2.6555 + 0.7891 \, SP + 0.0875 \, T$$
$$\quad (2.6) \quad\quad (18.3) \quad\quad (4.7)$$

$R^2 = 0.99;\ DW = 1.14$

Fluid Supply Equation

$$\ln Q^{fs} = 0.7200 + 0.7240 \ln Q^{fs}_{-1} + 0.1034 \ln \hat{P}^f - 0.1364 \ln \hat{P}^I - 0.0454 \ln P^e + u$$
$$\quad (1.9) \quad (7.0) \quad\quad\quad (2.5) \quad\quad\quad (-4.0) \quad\quad\quad (-2.2)$$

$R^2 = 0.89;\ DW = 1.40$

Retail Manufactured Price Instrument

$$P^m = 4.9210 \, SP + 25.5289 \, W + 1/(1 + 0.7816 \, L) \, u$$
$$\quad (3.5) \quad\quad\quad (13.8) \quad\quad\quad (6.6)$$

$R^2 = 0.99;\ DW = 1.81$

Table 1. Continued.

Manufactured Demand Equation

$$\ln Q^{md}/POP = -1.7644 - 0.9467 \ln \hat{p}^m + 0.0911 \ln p^{fo} + 0.4980 \ln Y - 2.8103 \ln A_1 - 0.0461 T + u$$
$$\qquad\qquad (-2.9)\quad (-5.7)\qquad\qquad (1.3)\qquad\qquad (2.0)\qquad\qquad (-6.5)\qquad\qquad (-4.6)$$
$$R^2 = 0.83; \; DW = 2.08$$

Class II Milk Price Equation

$$p^{II} = 0.3555 + 0.7891 \; SP + 0.0875 \; T$$
$$\qquad (2.6)\quad (18.3)\qquad (4.7)$$
$$R^2 = 0.99; \; DW = 1.14$$

Manufacturing Supply Equation

$$\ln Q^{ms} = 0.6759 + 0.6118 \ln Q^{ms}_{-1} + 0.6163 \ln \hat{p}^m - 0.2832 \ln \hat{p}^{II} + 0.0051 T + 1/(1 - 0.4975 L) u$$
$$\qquad\quad (2.0)\quad (4.7)\qquad\qquad (2.5)\qquad\quad (-2.6)\qquad\quad (3.8)\qquad\qquad (-2.5)$$
$$R^2 = 0.94; \; DW = 1.82$$

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* R^2 is the adjusted coefficient of variation, DW is the Durbin-Watson statistic, u is white noise, L is the lag operator, ln is the natural logarithm, and t-values are given in parentheses.

Table 2. Definitions of Variables Used in NEMPIS.[*]

Variable Name	Unit of Measurement	Description
CN	1,000 head	Number of cows in the U.S.
p^m	$/cwt.	3.67% butterfat average farm milk price deflated by the Consumer Price Index for all items (CPI; 1967 = 100)
FC	$/cwt.	Dairy ration costs deflated by the CPI
DTP	1 or 0	Intercept dummy (equals 1 for 1986-87)
PPC	lbs.	National average production per cow
T	integer	Trend variable; 1960=1, 1961=2,...
p^f	1967=100	Retail fluid milk price index
SP	$/cwt.	3.67% butterfat support price
W	$/hour	Average hourly wage rate in manufacturing sector
Q^{fd}	bil. lbs.	Fluid demand
POP	mil.	Civilian population
$\hat{p}^f$	1967=100	Retail fluid price instrument deflated by the CPI
p^b	1967=100	Retail nonalcholic beverage price index deflated by the CPI
Y	$1,000	Disposable per capita income deflated by the CPI
A_1	%	Percent of population under 19 years of age
A_2	%	Percent of population between 25 and 64
p^I	$/cwt.	3.67% butterfat Class 1 price
Q^{fs}	bil. lbs.	Fluid supply ($Q^{fd} = Q^{fs}$)
$\hat{p}^I$	$/cwt.	Class I price instrument deflated by the CPI
p^e	1967=100	Fuels and energy price index deflated by the CPI
p^m	1967=100	Retail manufactured price index
Q^{md}	bil. lbs.	Manufactured demand
$\hat{p}^m$	1967=100	Retail manufactured price instrument deflated by the CPI
p^{fo}	1967=100	Retail fats and oils price index deflated by the CPI
p^{II}	$/cwt.	3.67% butterfat Class 2 price
Q^{ms}	bil. lbs.	Manufactured supply ($Q^{md} = Q^{fs}$)
$\hat{p}^{II}$	$/cwt.	Class II price instrument deflated by the CPI
MILK	bil. lbs.	Total milk marketings
CCC	bil. lbs.	Milk surplus purchased by the government
TOTDEM	bil. lbs.	Total commercial demand for milk products

[*] Unless otherwise noted, all quantities are expressed in milk equivalent butterfat basis.

cant reduction in cows in 1986 and 1987 due to the DTP. To correct for autocorrelation, a first-order autoregressive error structure is imposed.

The production per cow (PPC) equation is estimated using OLS as a function of production per cow in the previous year, the real average milk price, lagged one year, real feed costs, and a trend variable (T). Lagged production per cow is used to reflect short term constraints on milk yields, real feed costs represent the most important variable cost of production to dairy farmers, and the trend variable is used as a proxy for genetic improvements in cows over time.

The retail fluid market consists of a retail fluid demand and supply equation, which are estimated simultaneously using two-stage least squares (2SLS). An instrumental variable is constructed for the endogenous retail fluid price (P^f) by regressing it on two exogenous variables: the support price (SP) and the average hourly wage in the manufactured sector (W). To deal with autocorrelation, a first-order autoregressive error structure is imposed. The resulting predicted value for the retail fluid price ($\hat{P}^f$) is used as an instrument for the actual fluid price in the retail fluid supply and demand equations.

Retail per capita fluid demand (Q^{fd}/POP) is estimated as a function of real retail fluid price instrument, the real price of nonalcoholic beverages (P^b), real disposable

income per capita (Y), percent of population between 25 and 64 years old (A_2), and a time trend. The real price of nonalcoholic beverages is used as a proxy for fluid substitutes, the percent of people between 25 and 64 captures the decline in fluid milk consumption in this age group, and the time trend is used as a proxy for changing consumer tastes away from high-fat products.

An important retail fluid supply determinant is the Class 1 price (P^I) paid by retail suppliers. Because P^I is endogenous, an instrumental variable is constructed by regressing it on the support price and a time trend. The resulting predicted value ($\hat{P}^I$) is used in the retail fluid supply function in place of the actual Class 1 price. Other retail fluid supply determinants include supply in the previous year, the real retail fluid price instrument, and the real energy price index (P^e). Retail supply lagged one year is included to capture short term production constraints on fluid supply, and the real energy price index is a proxy for energy costs, which is another important supply shifter.

The retail manufactured market consists of a retail manufactured demand and supply equation, which are also estimated simultaneously using two-stage least squares. An instrumental variable is constructed for the endogenous retail manufactured price (P^m) by regressing it on the support price and the average hourly wage in the manufactured sector. To deal with autocorrelation, a first-

order autoregressive error structure is imposed. As was the case with the retail fluid price instrument, predicted value for the retail manufactured price ($\hat{P}^m$) is used as an instrument for the actual manufactured price in the retail manufactured supply and demand equations.

Retail per capita manufactured demand (Q^{md}/POP) is estimated as a function of real retail manufactured price instrument, the real retail price for fats and oils (P^{fo}), real disposable income per capita, percent of population under 19 years old (A_1), and a time trend. The real retail price of fats and oils is used as a proxy for manufactured substitutes, the percent of people under 19 years old reflects the lower manufactured product consumption of this age bracket, and the time trend is used as a proxy for changing consumer tastes away from high-fat products.

An important retail manufactured supply determinant is the Class 2 price (P^{II}) paid by retail suppliers. As was the case with the retail fluid supply estimation, an instrumental variable is necessary here because P^{II} is endogenous. The instrument is constructed by regressing P^{II} on the support price and a time trend. The resulting predicted value ($\hat{P}^{II}$) is used in the retail manufactured supply function in place of the actual Class 2 price. Other retail manufactured supply determinants include supply in the previous year, the real retail manufactured price instrument, and a time trend. Retail supply lagged one year is included to capture short term production constraints on

manufactured supply, and the time trend is included to capture supply shifters such as changes in technology. To correct for autocorrelation, a first-order autoregressive error structure is imposed.

The Simulation Model

The farm market is defined by the estimated cow number and production per cow equations, one identity (milk marketings, the product of cow numbers time production per cow times 98.5%), and an equilibrium condition requiring milk marketings to equal commercial fluid and manufactured demand plus government purchases of dairy products via the dairy price support program. Based on the cow number equation in Table 1, the number of cows in any year t is equal to the following equation:

$$CN_t = \exp[.989 \ln CN_{t-1} + .06 \ln P^m_{t-1} - .08 \ln FC_t] - DTP_t,$$

where e and ln are the exponential and natural logarithm operators, respectively. To incorporate the option of a supply control program, an additional variable (DTP) is subtracted from cow numbers and is equal to the number of cows specified by the user that the government will remove in year t.

The option of using bST is incorporated by multiplying the estimated production per cow equation in Table 1 by one plus the product of the user defined increase in milk yields

of treated cows due to bST (I) times the cumulative adoption rate (C) times a binary variable (A) which equals 1 if bST is available and 0 otherwise. Production per cow in any year t is equal to the following equation:

$$PPC_t = (1 + I C Z) \exp[2.45 + .73 \ln PPC_{t-1} + .06 \ln P^m_{t-1} - .06 \ln FC_t + .005 T_t]$$

Milk marketings is simply the product of cow numbers and production per cow. However, since about 1.5% of milk production is not marketed commercially due to on-farm use, commercial milk marketings (MILK) are defined as the following in NEMPIS:

$$MILK_t = .985 \, CN_t \, PPC_t$$

Finally, the equilibrium condition between the farm and retail sectors is specified by the following condition:

$$MILK_t = Q^f_t + Q^m_t + CCC_t,$$

where: Q^f and Q^m are the equilibrium fluid and manufactured quantities in the commercial market and CCC is government purchases under the dairy price support program.

The Class 1 price is equal to the Class 2 price plus a fixed fluid differential which varies among all federal milk marketing orders. Since this is a national model, which

assumes one marketing order, the Class 1 price is equal to the Class 2 price plus the national average fluid differential ($2.30 per hundredweight). While processors must pay these class prices, the milk price received by all farmers is equal to the average of P^I and P^{II}, weighted by the percent of fluid and manufactured market utilization. That is,

$$P^m_t = P^{II}_t \ ((Q^m_t + CCC_t)/MILK_t) + P^I_t \ (Q^f_t/MILK_t)$$

In the fluid retail market, the equilibrium fluid price (P^f) equation is generated by setting the estimated fluid supply equation (Q^{fs}; see Table 1) equal to the estimated fluid demand equation (Q^{fd}) and solving for the retail fluid price. NEMPIS computes P^f for each year then substitutes it back into either the estimated supply or demand function to obtain the equilibrium quantity of fluid products (Q^f). An analogous procedure is done in the manufactured product market.

The rest of the equations in NEMPIS are accounting equations which define other variables. Total commercial demand (TOTDEM) is equal to the sum of fluid and manufactured product demand, i.e.:

$$TOTDEM_t = Q^f_t + Q^m_t$$

Finally, the quantity of government purchases is equal to the difference between milk marketings and commercial demand,

$$CCC_t = MILK_t - TOTDEM_t$$

EXAMPLES OF POLICY AND TECHNOLOGY SIMULATIONS

To illustrate NEMPIS output, this section summarizes the simulation solutions for four different policy and technology scenarios. The simulation period for all four scenarios is 1990 through 1995. In scenario 1, it is assumed that bST is not adopted, adjustments in the support price are based on the Food Security Act provisions, and there is no Dairy Termination Program. Scenario 2 is the same as the first, except that bST is assumed to be commercially available in 1991. In this scenario, it is assumed that milk yields in treated cows is 10% higher than non-treated cows, and that an additional 5% of all farmers adopt bST each year so that 25% of all farmers have adopted bST by 1995. Scenario 3 uses the same bST assumptions as the second scenario, but the support price is held constant at $10.60 per hundredweight, and 100,000 cows are removed under a DTP each year. Finally, scenario 4 is the same as the third scenario except that the bST adoption rate is 15% each year rather than 5%. The output for these four simulations is presented in Tables 3 and 4.

Table 3. NEMPIS Solutions for Scenarios 1 and 2, 1990-1995.[*]

Scenario 1 (Automatic Support Price Adjustments Without bST or DTP)

YEAR	CCC	SP	PPC	COW	PROD	AMP	DTP
1990	10.84	10.10	14849	9955	147.60	11.91	0
1991	8.73	9.60	15238	9727	148.00	11.61	0
1992	4.54	9.10	15563	9442	146.74	11.32	0
1993	1.11	9.60	15848	9160	144.99	11.82	0
1994	0.02	10.10	16172	8887	143.56	13.20	0
1995	0.01	10.60	16597	8684	143.96	13.72	0

YEAR	Q1	RFP	Q2	RMP	P1	P2	TOTDEM
1990	55.78	217.44	80.98	319.08	13.34	11.04	136.76
1991	56.48	212.87	82.79	324.76	13.03	10.73	139.27
1992	57.14	208.49	85.07	330.09	12.72	10.42	142.20
1993	57.36	207.09	86.52	340.31	13.21	10.91	143.88
1994	56.90	210.53	86.65	357.71	14.59	12.29	143.55
1995	56.45	213.85	87.50	373.51	15.12	12.82	143.95

Scenario 2 (Automatic Support Price Adjustments With bST, but no DTP)

YEAR	CCC	SP	PPC	COW	PROD	AMP	DTP
1990	10.84	10.10	14849	9955	147.60	11.91	0
1991	9.46	9.60	15314	9727	148.73	11.60	0
1992	6.51	9.10	15775	9442	148.72	11.31	0
1993	3.92	9.10	16243	9159	148.54	11.40	0
1994	2.21	9.60	16757	8867	148.35	11.89	0
1995	1.72	10.10	17347	8608	149.08	12.36	0

YEAR	Q1	RFP	Q2	RMP	P1	P2	TOTDEM
1990	55.78	217.44	80.98	319.08	13.34	11.04	136.76
1991	56.48	212.87	82.79	324.76	13.03	10.73	139.27
1992	57.14	208.49	85.07	330.09	12.72	10.42	142.20
1993	57.55	205.61	87.07	338.02	12.81	10.51	144.62
1994	57.61	205.09	88.53	349.63	13.29	10.99	146.14
1995	57.47	205.98	89.89	362.94	13.78	11.48	147.36

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[*] See text for variable definitions.

Table 4. NEMPIS Solutions for Scenarios 3 and 4, 1990-1995.*

Scenario 3 ($10.60/cwt. Support Price, 100,000 Cow Annual DTP With bST)

YEAR	CCC	SP	PPC	COW	PROD	AMP	DTP
1990	10.05	10.60	14849	9855	146.14	12.31	100
1991	9.79	10.60	15344	9620	147.39	12.39	100
1992	7.91	10.60	15861	9298	147.26	12.49	100
1993	6.71	10.60	16404	9031	147.93	12.57	100
1994	4.76	10.60	16977	8729	147.96	12.66	100
1995	3.07	10.60	17578	8456	148.41	12.75	100

YEAR	Q1	RFP	Q2	RMP	P1	P2	TOTDEM
1990	55.59	218.94	80.49	321.13	13.73	11.43	136.09
1991	56.00	216.73	81.60	329.78	13.82	11.52	137.61
1992	56.29	215.18	83.06	338.56	13.91	11.61	139.35
1993	56.48	213.93	84.74	347.94	14.00	11.70	141.22
1994	56.60	212.86	86.60	357.90	14.08	11.78	143.21
1995	56.69	211.98	88.65	368.37	14.17	11.87	145.33

Scenario 4 ($10.60/cwt. Support Price, 100,000 Cow Annual DTP With Higher bST Adoption Rate)

YEAR	CCC	SP	PPC	COW	PROD	AMP	DTP
1990	10.05	10.60	14849	9855	146.14	12.31	100
1991	11.23	10.60	15497	9620	148.84	12.39	100
1992	11.84	10.60	16291	9298	151.19	12.46	100
1993	13.93	10.60	17218	9030	155.14	12.53	100
1994	15.82	10.60	18269	8726	159.02	12.60	100
1995	18.46	10.60	19438	8450	163.79	12.67	100

YEAR	Q1	RFP	Q2	RMP	P1	P2	TOTDEM
1990	55.59	218.94	80.49	321.13	13.73	11.43	136.09
1991	56.00	216.73	81.60	329.78	13.82	11.52	137.61
1992	56.29	215.18	83.06	338.56	13.91	11.61	139.35
1993	56.48	213.93	84.74	347.94	14.00	11.70	141.22
1994	56.60	212.86	86.60	357.90	14.08	11.78	143.21
1995	56.69	211.98	88.65	368.37	14.17	11.87	145.33

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* See text for variable definitions.

While the principal use of NEMPIS is to compare differential impacts of various dairy policies and technologies, the program also appears to give plausible forecasts. For example, in the FSA support price adjustment scenario (Scenario 1) the support price gradually falls until it reached a low of $9.10 in 1992, and rises until it reaches a high of $10.60 in 1995. Under this scenario, milk production falls by 2.5%, while milk consumption increases by 5% between 1988 and 1995. The net result is CCC purchases declining steadily from over 10 billion pounds (butterfat milk equivalent) in 1990 to no purchases in 1994 and 1995. The decrease in milk production is due exclusively to decreases in cow numbers, as production per cow increases by almost 12% by the end of the simulation period. The increase in commercial milk consumption is due primarily to growth in Class 2 demand, as fluid consumption remains relatively constant. These results seem plausible and consistent with other dairy economists' economic predictions (e.g., see Carman; Keniston, et al.; and Miller).

The results of Scenario 2 are similar to the first simulation, except the support price (and milk price) are somewhat lower, and production and consumption are higher. This is not surprising since the assumed national increase in milk yields and adoption rates are relatively small. The higher milk production in the second scenario is due exclusively to higher production per cow (due to bST), since

cow numbers actually are lower than in Scenario 1. The higher commercial milk consumption of Scenario 2 is due to lower retail prices. Hence, this model indicates that some of the decreases in costs to retailers due to bST are passed along to consumers.

When the support price is frozen at $10.60 and there is an annual DTP of 100,000 cows with bST (Scenario 3), the resulting milk surpluses (CCC purchases) are slightly higher than in the first two scenarios. Total consumption in this scenario is lower than in both Scenarios 1 and 2. This is due to the result that farm prices, and hence retail prices are higher. With the higher adoption rate (Scenario 4), these differences are even more pronounced. In this case CCC purchases reach 18.5 billion pounds by 1995. This result is due to much higher production per cow and lower milk consumption. It is clear from these four examples that different policies and technologies produce vastly different equilibrium values for key market variables.

Because the equations in NEMPIS were estimated from time series data (1960-1989), the results of simulations with support prices nearer to the observed values give more accurate solutions than support price values well outside the observed range. For example, entering a support price of $0.00, or $25.00 per hundredweight would produce unrealistic solutions for market variables. The same is true for the bST parameters. For example, entering a national average increase in milk yields of 100% would

generate unrealistic solutions. Hence, it should be noted that NEMPIS is more accurate when user defined parameters are in line with observed historical levels.

NEMPIS is capable of simulating a wide variety of federal dairy policies. Any combination of support price and cow disposal program parameters may be simulated. At the same time, while not explicitly a part of this software, NEMPIS can also be used to analyze the impacts of mandatory supply control programs.

For example, suppose that a mandatory quota program contained the following features. Suppose that the current support price is raised and maintained at $13.00 per hundredweight indefinitely and that bST is not available. In return for this higher price, dairy farmers would be issued quotas that in the aggregate would require milk supply to not exceed 2 billion pounds of milk equivalent per year. Obviously this would entail a cut back in milk production, at least in the short run. Assuming that farmers reduce production exclusively by removing cows from production, one could use the fourth policy option in NEMPIS to simulate this policy.

This could be done by manually performing the following iterative procedure each year. Beginning in 1990, one would enter a support price of $13.00 per hundredweight and let the software determine the level of CCC purchases. Then, if CCC purchases are above 2 billion pounds, one should divide the difference between CCC purchases and 2 billion pounds by

production per cow to obtain the number of cows that would have to be culled in order to bring production down to the required level. If this is done for 1990, then farmers would have to eliminate 836,000 cows to stay within allowable production. Repeating this procedure for 1991 results in the requirement that 790,000 cows having to be removed to stay within quota production plus the 2 billion pounds reserve. This process could be done for any, or all of 1990 through 2008 in NEMPIS. It provides interesting comparative information on the impacts of a fundamentally different type of dairy policy on farm and retail markets.

SUMMARY

This paper has presented an overview of NEMPIS, a computer program designed to simulate the affects of a wide range of dairy policies and technologies on the national milk market. The structure of NEMPIS divides the dairy industry into farm and retail markets. Annual equilibrium values for a policy and technology simulation may be generated for any or all years between 1990 and 2008.

With the recent "market orientation" of dairy policy, NEMPIS should be useful to economists, dairy scientists, and policy makers in examining the impacts of various scenarios on the U.S. dairy market. NEMPIS is available to anyone wishing to use it by contacting the author and sending an IBM formatted 5.25 inch floppy diskette.

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