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Forecasting Class III and Class IV Milk Prices

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Ed Jesse and Jacob Schuelke[1]

Introduction

Beginning in the late 1990's, dairy farmers gained a new opportunity to manage price risk with the introduction of futures and options trading for milk and dairy products. The Chicago Mercantile Exchange (CME) currently trades several dairy contracts, including futures and options contracts for the Class III Price, the principal determinant of farm-level milk price for producers in major cheese-producing states.[2] There is active trading in Class III futures contracts 12-13 months into the future, and sufficient daily trading volume and open interest to ensure reasonable liquidity. Many dairy farmers are directly engaged in hedging and setting minimum prices through put purchases. Even more farmers are writing forward price contracts and minimum price contracts with dairy plants; contracts that are enabled by the plants' use of Class III futures and options to shift risk.

But despite the growing volume, trading in milk remains small in comparison to grain and livestock. Part of the reason for limited trading volume is that dairy futures trading is very new compared to grain and livestock trading. There is less experience with risk management strategies and a much smaller research base with respect to basis relationships and price forecasting. Dairy farmers are still "feeling their way."

With respect to price forecasting, dairy risk management seminars and workshops often stress the need for producers to study outlook information to determine whether a distant futures price is consistent with fundamental dairy supply and demand factors. Important supply and demand indicators are usually identified (e.g., trends in number of milk cows, cow/heifer ratios, milk/feed price ratios, commercial disappearance of dairy products, disposable income, etc.). But their relative importance is seldom discussed and their quantitative influence on price is never indicated. Hence, participants invariably raise questions about just how they should utilize outlook information and about what represents a "good" futures price in light of their expectations about future market conditions.

The purpose of this study is to provide a systematic, user-friendly method for forecasting Class III and Class IV prices. The user is allowed to vary regional milk production and stocks of manufactured dairy products to evaluate the sensitivity of point estimates.

A sequential process is developed to predict Class III milk prices up to 12 months in advance using widely-published outlook data as predictor variables. The first stage involves deriving monthly U.S. milk supply forecasts using trend extrapolations for regional milk cow numbers and milk production per cow. Users may modify trend values based on personal expectations.

In the second stage, the projected monthly U.S. milk supply is allocated to Class III and Class IV manufactured products (butter, cheddar cheese, nonfat dry milk, and dry whey). Underlying these forecasts is a set of econometric relationships that estimate production of the manufactured products based on total milk production and other variables.

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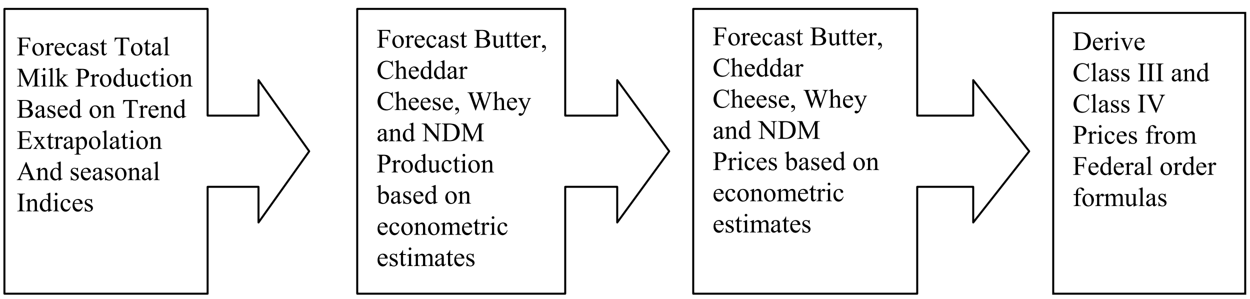
[2] The Coffee, Sugar and Cocoa Exchange (CSCE) initiated modern dairy futures and options trading in 1993 with cheddar cheese and nonfat dry milk contracts. The CSCE later added a deliverable contract for fluid milk and then cash-settled contracts for the Basic Formula Price and the Class III Price. However, trading interest in the identical CSCE and CME contracts gradually shifted to the CME. The CSCE de-listed its dairy contracts in mid-2001, leaving the CME as the only dairy futures exchange.

Next, Class III and IV product prices are forecast using a regression of product prices against production, stocks, and demand-related variables. Forecast product prices, in turn, are used to calculate milk component values and Class III and Class IV prices using federal milk order product price formulas.

These underlying economic relationships are embedded into a spreadsheet model that allows users to predict likely ranges of Class III and Class IV prices based on ranges of explanatory variables. A key feature of the spreadsheet is automatic updating of the econometric estimates for production and prices for the dairy products used in the Class III and Class IV milk price formulas. The updating is done by linking the price forecasting spreadsheet with others containing current values for most independent variables.

Schematically, the sequential process can be depicted as:



Milk Supply[3]

Annual milk cow and milk production per cow data were collected for the 48 contiguous U.S. states for the period 1950 through 2001. States were combined into 13 regions exhibiting similar climate, dairy production practices, and milk utilization. For the most part, the regions conform to the 11 current federal milk order marketing areas plus California, which is not regulated by a federal order. A 13th region was created by splitting the six New England states from the overall Northeast federal order area. States that are wholly or partly unregulated by federal orders (except California) were assigned to adjacent federal order markets. The resulting assignment of states to regions is shown in Appendix Table 1.

Regional trend estimates were derived for annual milk production per cow and average number of milk cows for the year. For milk yield, a linear trend with a starting year of either 1950 or 1975 was used. The criterion for selecting the starting year was minimization of absolute deviations from trend milk per cow for 1996-2001. Coefficients of the linear trend equations are shown in Table 1.

Table 1: Regional Milk per Cow Trend Estimates

Region	*2001 Milk per cow (Lbs)*	*Initial Year*	*Trend Coefficient 1950/75=1 (Lbs./Year)*	*Intercept (Lbs.)*	*R^2*
New England	17,477	1950	231	5,194	.99
Northeast	17,664	1975	277	10,229	.99
Appalachia	15,171	1950	235	3,156	.99
Southeast	14,326	1950	245	1,877	.99
Florida	15,758	1950	230	3,943	.99
Mideast	17,736	1950	232	5,050	.99
Upper Midwest	17,070	1975	254	10,085	.98
Central	16,891	1975	283	9,166	.99
Western	20,313	1975	360	10,125	.99
Southwest	17,976	1950	310	2,103	.99
Pacific Northwest	21,143	1975	362	11,911	.99
Arizona-Las Vegas	20,485	1975	316	10,408	.97
California	20,913	1950	277	6,717	.99

The R^2 values (percent of year-to-year variation in milk per cow associated with trend) indicate that annual changes in milk yield are very predictable. Improvements in genetics and management have yielded very steady absolute gains.

Changes in cow numbers do not show the same predictable linear pattern as milk per cow and regions differ considerably in how cow numbers have evolved since 1950. Cow numbers in some regions show a clear linear trend, especially in recent years. For other regions, trends appear to be longer-term and nonlinear in nature.

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[3] For a more complete discussion of the milk production projections, see Jesse, E.V. and J. Schuelke, "Regional Trends in U.S. Milk Production: Analysis and Projections," Marketing and Policy Briefing Paper No. 74, Dept. of Agricultural Economics, University of Wisconsin-Madison, December 2001.

Based on the nature of specific regional patterns, either a linear or log-linear trend specification was selected for cow numbers. A starting year no later than 1993 was chosen that reasonably fit the data and minimized absolute deviations from trend estimates for 1996-2000. The coefficients for the resulting trend equations for cow numbers are shown in table 2.

Table 2: Regional Cow Number Trend Estimates

Region	***2001 Cows (1,000)***	***Trend Specification***	***Initial Year***	***Trend Coefficient***	***Intercept***	***R^2***
New England	256	Linear	1987	(3.87)	318.5	.85
Northeast	1,376	Linear	1971	(17.16)	1,946.8	.81
Appalachia	334	Linear	1985	(16.92)	582.1	.99
Southeast	323	Log	1954	(668.35)	2,937.7	.98
Florida	153	Linear	1976	(1.63)	199.0	.80
Mideast	732	Log	1950	(656.22)	3,311.7	.94
Upper Midwest	1,947	Linear	1950	(45.87)	4,397.7	.94
Central	816	Log	1950	(1,300.50)	5,905.1	.94
Western	483	Linear	1993	22.88	276.6	.99
Southwest	593	Linear	1978	12.63	311.0	.94
Pacific Northwest	342	Linear	1970	2.99	264.3	.86
Arizona-Las Vegas	165	Linear	1993	5.03	123.9	.94
California	1,590	Linear	1993	38.11	962.1	.96

The milk yield per cow and cow number trends shown in tables 1 and 2 are extrapolated to forecast annual regional milk production. A regional monthly production index based on 1999-2001 seasonal patterns (see Appendix Table 2) was applied to the annual forecast to generate monthly production estimates.

To simplify using the spreadsheet model, the 13 regional milk supply forecasts are collapsed to four regions (see table 3). To generate a monthly U.S. production estimate, the user selects the month and year of interest (no later than the most distant futures contract) and can either accept the calculated point estimates or modify any or all of the regional milk supply estimates to personalize their milk production forecasts.

Table 3: Four-Region Definitions

Consolidated Area	Regions Included
Northeast	Mideast New England Northeast
Southeast	Appalachia Florida Southeast
Midwest	Central Upper Midwest

West	Arizona-Las Vegas California Pacific Northwest Southwest Western

Milk Allocation

Once milk is produced, it must be allocated to various dairy products. Largely because of high perishability and federal milk marketing order rules, fluid milk and cream have "first call" on the milk supply – milk will be allocated to meet fluid needs before it becomes available for other products. Among manufactured products, there is also an allocation hierarchy in the sense of some product needs being fully met before milk moves to other products. For example, soft manufactured dairy products and Mozzarella cheese are more likely to be manufactured under contract than cheddar cheese, butter, or nonfat dry milk (NDM). In general, Class III dairy products (hard cheeses) and Class IV products (butter and nonfat dry milk) have the lowest call on the milk supply – that is, these storable products tend to buffer milk supply and demand. More of these products are produced when milk supplies are large relative to demand and less when supplies are relatively short. Consequently, seasonal variation in production is relatively large.

Monthly allocation equations were estimated for the four dairy products that are used in the product price formulas for federal order Class III and Class IV prices. Factors expected to influence production of these products are total milk production across all regions, current stocks, annual trend, and seasonality. Annual trend accounts for longer-term changes in demand. Seasonality captures, in part, the "buffering" nature of these non-perishable dairy products – production would generally be expected to increase during the flush period and decrease when milk supplies are relatively short.

Note that product prices are not used as explanatory variables in the allocation equations. This implicitly assumes that manufacturers have no flexibility to alter the allocation of milk in response to relative price changes. This is an obviously naïve assumption in the long run. But reallocation across products is highly constrained in the short run by the existing number, location, product nix, and capacity of plants. The annual trend variable is expected to measure relative price related longer-term reallocation of the milk supply among products.

Both production and stocks are expressed on a per capita basis in the allocation equations. The December 2001 population base of 286 million is used along with an average monthly growth of .07% based on revised US Census Bureau population and projected growth patterns. In the spreadsheet, stocks are defaulted at the most current month's reported stocks. The user is shown the 5-year range in stocks for the forecast month and allowed to alter the default value based on the historical range.

The initial estimation period coincides with the time during which USDA's National Agricultural Statistics Service (NASS) has published monthly price estimates for the four Class III and Class IV products. This is April 1997 to December 2001 for cheese and September 1998 to December 2001 for butter, whey and NDM.

Butter

Other factors held constant, a change in monthly milk production of 1 billion pounds changes per capita butter production in the same direction by 0.055 pounds. Production trended downward over the estimation period by slightly more than 0.01 pounds per capita. The monthly dummy variable coefficients indicate that butter production is higher in the November-February period, which leads to stock accumulation, and lower in the summer and fall, when stocks are drawn down (see Figure 1).

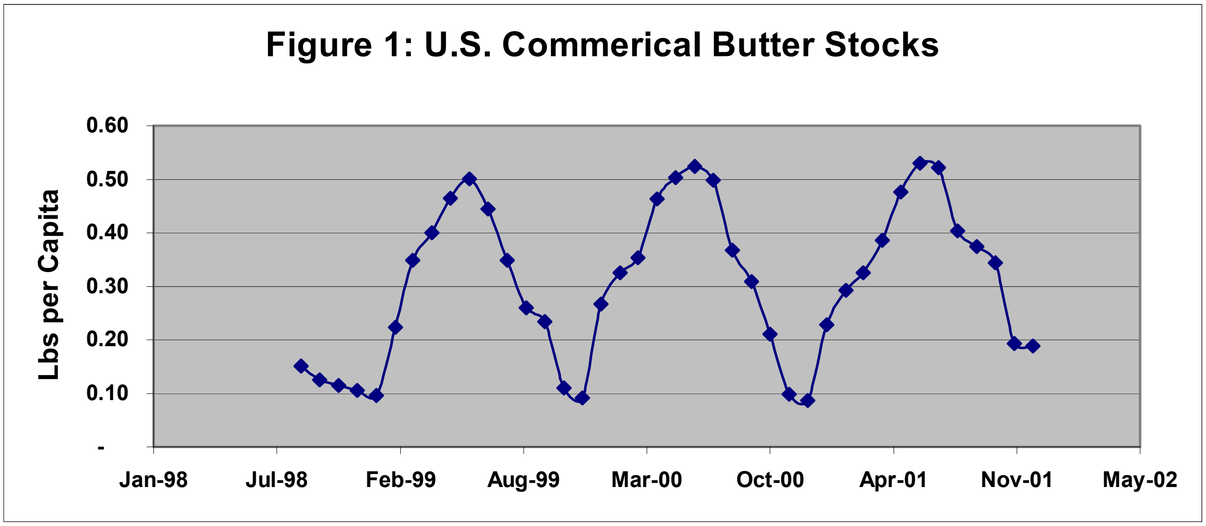

Table 4: Per Capita Butter Production

Regression Statistics	
Multiple R	0.9694
R Square	0.9396
Adjusted R Square	0.9095
Standard Error	0.0178
Observations	40

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	13	0.12766	0.00982	31.13986
Residual	26	0.00820	0.00032	
Total	39	0.13586		

Parameter Estimates

	Coefficients	*Standard Error*	*t-Statistic*	*P-value*
Intercept	28.4227	7.5161	3.7816	0.0008
Milk (Billion Lbs.)	0.0553	0.0146	3.7874	0.0008
Annual Trend	-0.0144	0.0038	-3.7577	0.0009
February	0.0028	0.0198	0.1430	0.8874
March	-0.0881	0.0163	-5.4011	0.0000
April	-0.0890	0.0147	-6.0485	0.0000
May	-0.1203	0.0174	-6.9066	0.0000
June	-0.1474	0.0146	-10.1172	0.0000
July	-0.1691	0.0147	-11.5279	0.0000
August	-0.1701	0.0155	-10.9533	0.0000
September	-0.1175	0.0192	-6.1243	0.0000
October	-0.0809	0.0151	-5.3491	0.0000
November	-0.0709	0.0179	-3.9512	0.0005
December	-0.0478	0.0139	-3.4441	0.0020

Monthly butter stocks were insignificant in explaining production and the variable was subsequently excluded from the relationship. This lack of significance is probably related to the predictable seasonal nature of stocks and the associated high correlation with the monthly dummy variables.

Cheddar Cheese

Total milk supply, commercial American cheese stocks[4], monthly dummy variables and an annual trend variable were used to estimate monthly cheddar cheese production. The results show that per capita cheddar cheese production increases by about 0.13 pounds per 1 billion pound increase in monthly milk production and decreases by about 0.04 pounds per 1 pound increase in per capita American cheese stocks. Adjusted for changes in the milk supply, per capita cheddar cheese production has trended downward by about 0.02 pounds. This does not suggest that cheddar cheese production is declining, but it does confirm that with rising milk production over time, a higher proportion of the milk supply is being allocated to other cheese varieties.

Most of the monthly dummy variable coefficients are not significantly different from zero. Production is seasonally higher in the winter months, but the seasonal relationship is weak compared to butter.

Table 5: Per Capita Cheddar Cheese Production

Regression Statistics	
Multiple R	0.9227
R Square	0.8513
Adjusted R Square	0.8017
Standard Error	0.0234
Observations	57

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	14	0.1314	0.0094	17.1731
Residual	42	0.0230	0.0005	
Total	56	0.1544		

Parameter Estimates

	Coefficients	*Standard Error*	*t Statistic*	*P-value*
Intercept	35.0823	8.4740	4.1400	0.0002
Milk (Billion Lbs)	0.1279	0.0186	6.8859	0.0000
Year	-0.0180	0.0043	-4.1508	0.0002
Stocks (lbs. per Capita)	-0.0396	0.0309	-1.2828	0.2066
February	0.0607	0.0242	2.5069	0.0161
March	-0.0408	0.0187	-2.1794	0.0350
April	-0.0055	0.0160	-0.3447	0.7321
May	-0.0413	0.0194	-2.1214	0.0398
June	0.0035	0.0169	0.2077	0.8364
July	0.0176	0.0176	0.9966	0.3247

[4] Separate cheddar cheese stock data are not reported. American cheese includes Colby and Monterrey Jack varieties. Reported American cheese stocks are principally cheddar styles.

August	-0.0071	0.0204	-0.3485	0.7292
September	0.0337	0.0251	1.3424	0.1867
October	-0.0020	0.0182	-0.1104	0.9126
November	0.0151	0.0213	0.7093	0.4821
December	0.0111	0.0159	0.6946	0.4911

Dry Whey

Whey is a by-product of cheese making. Consequently, cheese (rather than milk) production, is used in the whey production estimate. Dry whey stocks were not significant in explaining whey production and the variable was excluded. Monthly dummy variables to capture seasonality were not included since there is no a priori reason to expect seasonality in whey recovery. Annual trend was included to identify any temporal change in the amount of whey commercially recovered and dried per unit of cheddar cheese produced.

As expected, whey production is strongly correlated with cheese production. The annual trend coefficient is negative. This indicates that cheddar production as a percentage of total cheese production was declining over the estimation period. Consequently, whey output (from all cheese) per unit of cheddar cheese was also declining. This is likely reflecting expanded production of "Value Added" whey products like Whey Protein Concentrate.

Table 6: Per Capita Whey Production

Regression Statistics	
Multiple R	0.7891
R Square	0.6227
Adjusted R Square	0.6023
Standard Error	0.0170
Observations	40

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	2	0.0176	0.0088	30.5345
Residual	37	0.0107	0.0003	
Total	39	0.0283		

Parameter Estimates

	Coefficients	*Standard Error*	*t Statistic*	*P-value*
Intercept	16.7317	5.4864	3.0496	0.0042
Cheddar Production	0.3741	0.0510	7.3380	0.0000
Annual Trend	-0.0084	0.0027	-3.0430	0.0043

Non-fat Dry Milk

The dairy price support program had a significant impact on NDM markets during the estimation period. In September 1998, per capita government stocks of NDM were about .42 lbs. That number steadily increased during the next three years, peaking at 2.95 lbs. in September 2001. Since then, stock levels have eased somewhat, partly as a result of the May 2001 butter/power price support tilt that decreased the support level for powder and increased the level for butter.

To accommodate the possible effect of the price support tilt on NDM production, a dummy variable equal to 1 before the tilt and 0 after was included in the specification. Government and commercial stocks were also separately included because of the magnitude of CCC stocks of NDM in comparison to butter or cheese stocks. The tilt dummy variable coefficient proved insignificant and the variable was subsequently dropped (it was significant in the NDM price estimate). Also, the coefficients for CCC and commercial stocks were not statistically different, so stocks were combined into a single variable.

NDM production increases by about 0.05 pounds per capita per billion pound increase in milk production. A one-pound increase in stocks reduces NDM production by about 0.09 pounds. There was an upward trend in NDM production (adjusted for milk production) over the estimation period, about 0.1 pound per capita per year. NDM production shows a seasonal pattern similar to butter.

Table 7: Per Capita Non-fat Dry Milk Production

Regression Statistics	
Multiple R	0.9671
R Square	0.9354
Adjusted R Square	0.8992
Standard Error	0.0224
Observations	40

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	14	0.1811	0.0129	25.8443
Residual	25	0.0125	0.0005	
Total	39	0.1936		

Parameter Estimates

	Coefficients	*Standard Error*	*t-Statistic*	*P-value*
Intercept	-199.1599	53.0186	-3.7564	0.0009
Milk (Billion Lbs)	0.0503	0.0226	2.2241	0.0354
Year	0.0995	0.0266	3.7367	0.0010
Stocks (lbs. per Capita)	-0.0902	0.0246	-3.6676	0.0012
February	0.0680	0.0268	2.5397	0.0177
March	0.0162	0.0240	0.6745	0.5062
April	0.0754	0.0224	3.3631	0.0025
May	0.0647	0.0309	2.0963	0.0463
June	0.0700	0.0238	2.9455	0.0069
July	0.0325	0.0244	1.3302	0.1955
August	0.0001	0.0244	0.0026	0.9980
September	0.0015	0.0256	0.0583	0.9539
October	0.0011	0.0230	0.0486	0.9616
November	0.0285	0.0239	1.1887	0.2457
December	0.0948	0.0248	3.8168	0.0008

Product Price Estimates

The next stage of the sequential Class III/IV price forecasting process is to derive product price forecasting equations that use as input the forecast production of Class III and Class IV products from the allocation equations. Price-dependent demand relationships were estimated for butter, cheddar cheese, dry whey and NDM for the period since the inception of NASS price reporting through December 2001. The general specification regressed deflated (producer price index for crude foodstuffs, 2000=100) NASS monthly weighted average prices against per capita total supply (production plus current inventories), deflated (CPI-U, 1996=100) per capita disposable income, and monthly dummy variables to detect seasonality in demand.

Butter

NASS has reported butter prices since September 1998. However, prices in late 1998 were abnormally high and likely driven by unusual speculative pressures. So the estimation period was shortened to January 1999 – December 2001.

As expected *a priori*, butter prices are negatively related to total monthly butter supply and positively related to income. Adjusted for butter supply and income, monthly prices are higher in the summer and reach their lowest levels in the winter. This price pattern matches butter inventory patterns, and is consistent with storage costs being passed on to customers who purchase butter during low production periods. It also confirms stronger butterfat demand in the summer months when ice cream manufacturers compete with butter makers for the cream supply.

Table 8: NASS Butter Price

Regression Statistics	
Multiple R	0.7960
R Square	0.6337
Adjusted R Square	0.4172
Standard Error	0.2052
Observations	36

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	13	1.6032	0.1233	2.9275
Residual	22	0.9268	0.0421	
Total	35	2.5300		

Parameter Estimates

	Coefficients	*Standard Error*	*t-Statistic*	*P-value*
Intercept	(5.0779)	1.5651	(3.2445)	0.0037
Deflated PC Income ($1,000)	0.3108	0.0689	4.5101	0.0002
Per Capita Supply	(1.6322)	0.7460	(2.1879)	0.0396
February	0.0834	0.1695	0.4920	0.6276
March	0.1984	0.1787	1.1102	0.2789
April	0.2835	0.1958	1.4480	0.1617
May	0.4685	0.2217	2.1127	0.0462
June	0.6005	0.2062	2.9127	0.0081
July	0.4163	0.1854	2.2453	0.0351
August	0.1626	0.1735	0.9370	0.3589
September	0.1633	0.1743	0.9368	0.3590
October	(0.0580)	0.1718	(0.3374)	0.7390
November	(0.2745)	0.2197	(1.2491)	0.2248
December	(0.2580)	0.2007	(1.2853)	0.2120

Cheddar Cheese

The NASS cheddar cheese price series extended from April 1997 to December 2001.[5] The price relationship shows significant coefficients and correct signs for supply and income, but the goodness of fit is the poorest among the four price equations. This is partly due to using inventories that include non-cheddar varieties. The only significant monthly dummy variable coefficients are for July-September, and show stronger (cheeseburger-related?) demand during the summer months.

[5] NASS reports weekly prices for cheddar cheese manufactured in 40-pound blocks and 500-pound barrels. The price used here is the monthly weighted average block and barrel cheddar price used to compute federal order prices. The weights used are reported production of the two cheddar styles. The barrel price is adjusted to 38 percent moisture and is augmented by 3 cents per pound in the averaging process.

Table 9: NASS Cheddar Price

Regression Statistics

Multiple R	0.6951
R Square	0.4831
Adjusted R Square	0.3269
Standard Error	0.1811
Observations	57

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	13	1.3182	0.1014	3.0919
Residual	43	1.4102	0.0328	
Total	56	2.7284		

Parameter Estimates

	Coefficients	*Standard Error*	*t-Statistic*	*P-value*
Intercept	0.8932	0.6558	1.3620	0.1803
Deflated PC Income ($1,000)	0.1363	0.0385	3.2120	0.0025
PC Total Supply	-0.8460	0.1720	-4.9178	0.0000
February	-0.1273	0.1284	-0.9911	0.3272
March	-0.0141	0.1286	-0.1093	0.9135
April	-0.0302	0.1221	-0.2470	0.8061
May	0.0880	0.1269	0.6938	0.4916
June	0.1579	0.1266	1.2477	0.2189
July	0.2638	0.1263	2.0884	0.0427
August	0.3254	0.1264	2.5752	0.0135
September	0.2764	0.1228	2.2500	0.0296
October	0.1053	0.1216	0.8661	0.3912
November	-0.0979	0.1234	-0.7934	0.4319
December	-0.0059	0.1221	-0.0483	0.9617

Dry Whey

Income was not significant in explaining whey prices, so the variable was excluded. Adjusted for available supply, dry whey prices tended to be lower in the fall months, possibly reflecting stock behavior.

Table 10: NASS Dry Whey Price

Regression Statistics	
Multiple R	0.8414
R Square	0.7080
Adjusted R Square	0.5782
Standard Error	0.0232
Observations	40.0000

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	13	0.0352	0.0029	5.4558
Residual	26	0.0145	0.0005	
Total	39	0.0497		

Parameter Estimates

	Coefficients	*Standard Error*	*t-Statistic*	*P-value*
Intercept	0.5544	0.0492	11.2730	0.0000
PC Total Supply	-0.6663	0.0912	-7.3034	0.0000
February	-0.0263	0.0192	-1.3718	0.1814
March	-0.0100	0.0189	-0.5303	0.6002
April	-0.0110	0.0189	-0.5799	0.5668
May	0.0054	0.0191	0.2829	0.7794
June	0.0051	0.0190	0.2701	0.7892
July	0.0105	0.0189	0.5520	0.5855
August	-0.0034	0.0190	-0.1781	0.8600
September	-0.0260	0.0187	-1.3918	0.1753
October	-0.0319	0.0187	-1.7013	0.1004
November	-0.0296	0.0187	-1.5794	0.1259
December	0.0152	0.0178	0.8582	0.3983

Non-fat Dry Milk

Non-fat dry milk price has the expected positive relationship to income and negative relationship to stocks. Ceteris Paribus, NDM prices tend to be about 5 cents per pound high in the summer months.

As noted earlier, the federal dairy price support program altered relative butter-NDM purchase prices in May 2001. This “tilt” is represented in the NDM price equation by a dummy variable that is set at 1 during the pre-tilt period and 0 post-tilt. The coefficient indicates that the tilt lowered market prices for NDM by about 7.5 cents per pound.

Table 11: NASS Non-fat Dry Milk Price

Regression Statistics

Multiple R	0.9164
R Square	0.8399
Adjusted R Square	0.7502
Standard Error	0.0280
Observations	40

Analysis of Variance

	Degrees Of Freedom	*SS*	*MS*	*F*
Regression	14	0.1030	0.0074	9.3655
Residual	25	0.0196	0.0008	
Total	39	0.1227		

Parameter Estimates

	Coefficients	*Standard Error*	*t-Statistic*	*P-value*
Intercept	-0.5505	0.7804	-0.7054	0.4871
Deflated PC Income ($1000)	0.0686	0.0343	1.9995	0.0565
PC Total Supply	-0.0691	0.0183	-3.7806	0.0009
February	0.0101	0.0229	0.4414	0.6627
March	-0.0084	0.0230	-0.3667	0.7169
April	0.0129	0.0235	0.5504	0.5869
May	0.0195	0.0239	0.8177	0.4213
June	0.0516	0.0245	2.1022	0.0458
July	0.0499	0.0241	2.0653	0.0494
August	0.0436	0.0237	1.8413	0.0775
September	0.0181	0.0218	0.8306	0.4141
October	0.0007	0.0219	0.0339	0.9732
November	-0.0006	0.0233	-0.0248	0.9804
December	0.0287	0.0219	1.3136	0.2009
Tilt	0.0741	0.0192	3.8608	0.0007

Class III and Class IV Price Estimates

In the final stage of the sequential price forecasting model, product price forecasts are incorporated into the federal milk marketing order product price formulas to generate Class III and Class IV prices.

The federal order price formulas are complex. Milk component prices are first derived from product prices using assumed yields of product per pound of component and manufacturing, or "make," allowances. Then, skim and whole milk values are calculated based on assumed milk composition. The derivation process can be simplified by mathematically collapsing the several formulas to express the Class III and Class IV prices directly in terms of the NASS monthly product prices:

Class III Price = 10.26 X Cheese Price – 0.40 X Butter Price + 5.88 X Whey Price – 2.47

Class IV Price = 4.268 X Butter Price + 8.685 X NDM Price – 1.707

The product prices used in the classified pricing formulas are the estimates from the regression equations.

The Spreadsheet Model

The price forecasting spreadsheet is designed to provide crude monthly Class III and Class IV price forecasts based on the trend and econometric estimates discussed above. More important, it can help users understand how milk production and commodity inventory levels are likely to affect Class III and Class IV prices.

The user downloads the spreadsheet from the web site, *Understanding Dairy Markets* (http://www.aae.wisc.edu/future/). When the file is opened, the user is prompted to update links. Updating re-estimates all regression equations using the most recent published values for explanatory variables and inserts current values for product stocks.

Using worksheet tabs, the user first enters the forecast month and year. This generates related monthly milk production forecasts for four U.S. regions in another worksheet. The user may alter one or more of the point forecasts by inserting percentage deviation factors, which recalculate regional milk production.

Next, the user is shown inventory levels in a third worksheet – the most current month's inventory and the five-year range for the forecast month. Current inventories are used in the allocation and price estimates unless altered by inserting a percentage deviation factor.

Given this user input, the spreadsheet calculates Class III and Class IV prices using the estimated milk allocation equations, the product price equations, and the federal order formulas. The forecast milk prices and the underlying product prices are shown in a fourth worksheet.

The value of the spreadsheet is not in the prices that it generates as much as it is in demonstrating the sensitivity of the price forecasts to changes in milk production, inventories, and time of year. For example, the likely effect of a drought in the northeast could be demonstrated by reducing milk production in the northeast from the trend point estimate. The effect of reduced demand for butter could be simulated by increasing butter inventories.

A word of caution: The price relationships in the model are based on historical inventory and production levels that have generally followed predictable patterns. So estimates of large deviations are not advisable. Users are constrained to limit percentage deviations of no more than 10 percent in order to prevent unrealistic forecasts.[6]

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[6] The product prices are floored at CCC purchase prices for butter, cheese, and nonfat dry milk and at the other solids formula make allowance ($0.14 per pound) for dry whey. However, no upper bounds are imposed.

Since the spreadsheet uses forecast rather than actual values, some assumptions with respect to population growth and inflation must be incorporated.

Production and stocks are expressed on a per capita basis. Monthly population used to derive per capita values was taken from updated US Census estimates (December 2001) and increased at the rate of .074 percent/month. Population cannot be altered by the user directly. But inventory levels could be altered to demonstrate the effect on prices of population growth substantially greater or less than trend.

The Consumer Price Index used to deflate per capita disposable income is extrapolated from a 31 year linear trend. This trend estimate has an R^2 value of .9845 and a standard deviation of 2.15 percent. The producer price index used to deflate product prices is extrapolated from a 31 year
logarithmic trend with an R^2 value of .8045 and a standard deviation of 11.64 percent. Since only short-term forecasts are permitted, users are not given the option of altering the deflators.

Appendix Table 1: Assignment of States to Milk Production Regions

Region	*Included States*	*Region*	*Included States*
New England	Maine New Hampshire Vermont Massachusetts Connecticut Rhode Island	Central	Illinois Iowa Nebraska Kansas Missouri Oklahoma Colorado
Northeast	New York Pennsylvania Maryland New Jersey Delaware	Western	Wyoming Montana Idaho Utah
Appalachia	Virginia Kentucky North Carolina South Carolina	Southwest	New Mexico Texas
Southeast	Tennessee Arkansas Alabama Mississippi Georgia Louisiana	Pacific Northwest	Oregon Washington
Florida	Florida	Arizona-Las Vegas	Arizona Nevada
Mideast	Ohio West Virginia Michigan Indiana	California	California
Upper Midwest	Wisconsin Minnesota North Dakota South Dakota		

Appendix Table 2: Regional Monthly Milk Production Indexes, 1999-2001

Region	*Seasonal Index of Monthly Milk Production*					
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**
New England	99.71%	100.65%	101.40%	102.33%	104.19%	103.00%
Northeast	99.02%	101.15%	102.89%	103.99%	104.79%	102.69%
Appalachian	102.46%	104.86%	106.64%	108.49%	105.41%	98.12%
Southeast	106.11%	111.94%	110.29%	108.64%	106.99%	100.20%
Florida	109.08%	115.34%	117.82%	115.16%	111.22%	103.44%
Mid East	98.99%	101.59%	101.69%	102.75%	104.69%	102.77%
Upper Mid West	99.95%	101.59%	102.84%	103.40%	104.23%	102.81%
Central	101.36%	103.46%	103.60%	104.38%	104.35%	101.33%
Western	97.73%	97.04%	97.36%	99.61%	101.33%	103.31%
Southwest	102.27%	106.61%	109.53%	109.26%	107.93%	102.19%
Pacific Northwest	98.35%	99.33%	100.20%	102.65%	102.61%	102.90%
Arizona – Las Vegas	104.75%	109.64%	111.77%	113.69%	110.24%	103.33%
California	99.84%	100.92%	102.04%	104.12%	103.37%	101.33%
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
New England	100.16%	98.98%	98.09%	96.40%	96.49%	98.59%
Northeast	99.62%	98.54%	97.43%	96.29%	96.45%	97.14%
Appalachian	93.27%	94.52%	94.16%	95.40%	97.36%	99.30%
Southeast	93.41%	86.63%	89.23%	91.84%	94.45%	100.28%
Florida	91.52%	82.47%	81.56%	81.11%	90.44%	100.84%
Mid East	100.44%	98.30%	97.35%	96.00%	96.63%	98.81%
Upper Mid West	99.36%	97.97%	97.09%	96.14%	96.16%	98.46%
Central	97.43%	95.54%	96.06%	96.41%	97.72%	98.35%
Western	103.59%	102.97%	101.19%	99.92%	98.12%	97.84%
Southwest	93.73%	90.35%	90.53%	94.06%	95.35%	98.20%
Pacific Northwest	101.98%	100.59%	99.86%	97.93%	96.62%	96.98%
Arizona – Las Vegas	90.77%	84.12%	86.09%	92.19%	94.72%	98.67%
California	99.06%	97.94%	97.18%	98.18%	97.93%	98.09%