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RETAIL PRICE PROJECTIONS FOR MILK, CHEESE AND EGGS, WITH IMPLICATIONS FOR THE WIC PROGRAM

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RETAIL PRICE PROJECTIONS FOR MILK, CHEESE AND EGGS, WITH IMPLICATIONS FOR THE WIC PROGRAM

Background

Retail food prices change from year to year as factors influencing production and consumption of agricultural products change. Factors affecting retail food prices include weather, changes in farm programs, changes in on-farm production costs, changes in processing, distribution and retailing costs, and changes in consumer demand for food.

Although retail food prices fluctuate throughout the year, federal appropriations for the WIC program are fixed for each year. Changes in program participation are made throughout the year based on the budget allocation and expected retail prices of WIC eligible food items. Neither the USDA nor other federal agencies publish price projections from retail products that would assist in planning for the WIC program. Thus, retail price projections developed in this study are used to estimate the number of potential clients that could be accommodated by a given WIC budget in North Carolina.

Objectives and Methodology

The objectives of this project were twofold:

1. to develop a mechanism for forecasting North Carolina retail prices for fluid milk, cheese and eggs on an annual basis, and
2. to provide price forecasts on a biannual basis to assist the planning and management of the North Carolina WIC program budget.

The methodology consisted of (a) estimating equations that explain changes in the retail prices of milk, cheese and eggs in terms of the farm prices of these commodities and the cost of processing them; and (b) using the estimated equations to generate forecasts of changes in the retail prices (from the base period), given projections of farm prices and processing costs. The models are based on quarterly observations that allow an examination of whether retail prices are influenced by seasonal

factors. However, because retail prices may not fully respond to changes in farm prices or processing costs within the same quarter, the models generally include farm and processing prices from one or two of the previous quarters. In more technical terms, the models are described as single-equation structural models estimated by least squares regression techniques.

The most simple forecasting model would project next period's retail price from farm price and processing costs in the current quarter. Generally, however, price data for the current period are not immediately available, and there is a need to project beyond the next quarter. Consequently, forecasting retail prices also requires that forecasts be made of farm and processing prices.

In constructing the forecasting models below, an important objective has been to make them simple to use. This requires that price data on the retail products and the farm and processing inputs be readily available. Similarly, it requires that price projections on the farm and processing inputs be available.

Ideally, the models would have used prices from North Carolina. While North Carolina farm prices are published regularly, retail prices and the prices of processing inputs for North Carolina are not available. Therefore, the forecasting models presented below are based on average U.S. prices or on the prices in major indicator markets. The assumption underlying this approach is that price movements in North Carolina closely reflect what is happening in the rest of the United States.

Model Specification and Selection

Model selection and specification involves identifying a set of variables that explain or predict the behavior of the price series of interest, in this case the retail prices of milk, cheese and eggs. The main choices are between North Carolina or U.S. farm prices and between the Food Marketing Cost Index and the U.S. CPI for processing costs. Other issues requiring consideration include whether there are seasonal influences on retail prices and whether changes in farm or processing input prices are reflected immediately in retail prices or after a lag of one or two quarters.

Some of the criteria used in selecting the forecasting models have already been mentioned. These include the availability of an historical series on prices and the availability of projections on the prices of the farm and processing inputs.

The other important criterion on which to discriminate between models is their forecasting ability. Obviously the ability of a model to forecast cannot be measured until after the event. Hence, models normally are assessed on the basis of how well they explain the past behavior of the price series being forecast.

A wide variety of models were estimated and tested. Only a sample of these are discussed in detail below. It was found that models based on U.S. farm prices, that is, on the New York price of eggs and the MW35 milk price, had better explanatory powers than those based on farm prices in North Carolina. Hence, only these models are presented below.

The strategy followed was first to estimate "full" models including seasonal dummy variables, current and lagged farm price, and current and lagged marketing cost index and the CPI index. The forecasting literature suggests that parsimonious or "reduced" models--those containing a subset of explanatory variables from the full models--are likely to have better forecasting abilities than the full models. A number of reduced models were estimated for each product and the one that performed best according to criteria discussed here has been presented below.

Likelihood ratio tests were applied to test whether omitting a group of variables significantly reduced the explanatory powers of the model. The test statistic is $\lambda = -2(L_r - L_u)$, where L is the log of the likelihood function for the restricted (r), and unrestricted models (u), and λ has a χ^2 distribution with the number of degrees of freedom being the number of coefficients restricted to being zero. The critical value of χ^2 at the 5 percent level is 5.99 for 2 degrees of freedom, 7.82 for three degrees of freedom and 9.49 for four degrees of freedom.

Another important test on which to judge models is the behavior of their residuals. The most commonly applied test is whether the residuals are correlated through time, and this is measured by reference to test statistics such as the Durbin-Watson statistic, which is a test for first order serial correlation, and the Q-statistic, which tests jointly for

autocorrelation of all orders up to the specified lag length. The Q-statistic for the residuals from these models was estimated for 20 lags and is reported in the tables. The critical χ^2 value for this lag length (k = 20) at a 5 percent significance level is 31.41.

The models also can be assessed in terms of their abilities to simulate the behavior of the actual price series. Several measures of this ability are also presented in the tables. Among them are the correlation between the actual and predicted series, which should be close to one; the root mean squared error (the sum of squares of the differences between predicted and actual values of the price series in question), which should be small; and Theil's inequality coefficient, which should be close to zero. A final criterion on which to evaluate the models is their ability to track the behavior of the actual series, which is measured by the number of times they fail to predict a turning point or predict one that does not eventuate. Turning points were counted from plots of actual and predicted values of the price under analysis. There are formal definitions of what constitutes a turning point error, but in this report an error has been counted as a clear divergence in actual and predicted values from their plots, and hence some small errors have been ignored. These forecasting criteria are discussed in more detail in Pindyck and Rubinfeld (1981, pp. 360-367).

One approach to discriminating between alternative models is to compare their out-of-sample forecasting capabilities. This was done by estimating the models over a reduced sample period from 1978 until the end of 1988 and then comparing price projections from the models with actual prices from 1989 until 1991. However, this test provided little basis for discriminating between the full and reduced models. Presumably the full and reduced models were not sufficiently different for this test to be effective.

The elasticities of retail price with respect to farm price and marketing costs are likely to be less than one and to approximate the input's share in total costs if the models are to be consistent with expectations about behavior in the processing sector, and if input prices are exogenous to the market. The mean values of all variables can be found in Appendix 1. Because the models contain lagged variables, there

are short- and long-run elasticities. The long-run elasticities are calculated by assuming that the current and lagged values of the variables are equal, which means that the change in retail price with respect to a change in input price is the sum of the coefficients on the current and lagged input price. Elasticities have been calculated for the restricted models.

Price Data

The price series used in this project have been included as an appendix to the report and the variables used are defined in Table 1. The data series extends from 1978 until the end of the second quarter 1991. For most variables the data have been collected on a monthly basis and then converted to a quarterly basis by a simple averaging procedure.

In both the milk and cheese forecasting models, the farm milk price variable has been the Minnesota-Wisconsin price for manufacturing milk with 3.5% butterfat, MW35. This series is published by the USDA but they do not make projections for this series. Dr. Geoff Benson, Associate Professor in the Department of Agricultural and Resource Economics, North Carolina State University (personal communication) has made the projections on MW35 used to forecast retail milk and cheese prices. The retail prices for milk and cheese are the CPIs for fresh whole milk and for cheese for urban consumers published by the Bureau of Labor Statistics.

The egg forecasting model is based on the BLS series for the retail price of eggs in the United States and on the New York wholesale price of cartoned grade A large eggs, which is published by the USDA and for which projections are available.

Two price series have been used to account for changes in the cost of processing farm products into retail products. The USDA prepares and publishes the Food Marketing Cost Index, but it does not publish projections for this series. This index of marketing costs is not specific to one product such as milk but reflects average changes in processing costs over a range of food products. The other price series used to approximate changes in processing costs was the CPI for all items. Adding the CPI as an explanatory variable also served as an alternative to deflating all prices by the CPI to remove a general trend in prices due to

Table 1. Definition of variables

Variable	Definition
D:	As a prefix to variable names denotes that data have been differenced
(-1), (-2):	Variables lagged 1 and 2 periods
C:	Constant term
Q2:	Seasonal effect in second quarter
Q3:	Seasonal effect in third quarter
Q4:	Seasonal effect in fourth quarter
QMCOST:	USDA Index of Marketing Costs
CPIUS:	U.S. Consumer Price Index
RUSEGG:	Retail price of U.S. eggs
NYEGGS:	Wholesale price of U.S. eggs
CPIFWM:	U.S. CPI for fresh whole milk
CPICH:	U.S. CPI for Cheese
MW35:	Minnesota-Wisconsin price for 3.5% butterfat milk
R^2:	Correlation coefficient
D-W:	Durbin Watson statistic
LLF:	Log Likelihood Function
Q:	Q statistic for autocorrelation of residuals
RMSE:	Root-mean-squared-error
THEIL:	Theil's (1966) inequality coefficient
TPE:	Turning point errors
CI:	Confidence interval

SOURCES: See Appendix 2.

inflation. Projections for the CPI are made by the Federal Reserve Bank in Cleveland. The relationship between the CPI and the Food Marketing Cost Index has been estimated and projections for the marketing cost index have been made from this relationship using projections for the CPI.

Projections for Explanatory Variables

To forecast retail prices of milk, cheese and eggs, forecasts of the explanatory variables are required. Forecasts of the CPI were obtained from the Federal Reserve Bank of Cleveland. The projected annualized rates of change in the CPI for the next 6 quarters until the end of 1992 are 3.58, 3.86, 3.89, 3.79, 4.02 and 3.98. An approximate estimate of the quarterly change in the CPI was estimated by dividing by 4. Projected levels of the CPI have been obtained by multiplying the level in the last quarter by the projected quarterly change. Hence, the projected level of the CPI for the third quarter of 1991 was 136.0*(1+0.0358/4) or 137.2. The projection for the fourth quarter was 137.2*(1+0.0386/4) or 138.5. The projections for the first three quarters of 1992 were 139.8, 141.2 and 142.6.

The USDA does not provide a forecast of the quarterly index of marketing costs, but it has been growing more slowly than the CPI in recent quarters. Another approach to projecting the quarterly marketing cost index is to establish a relationship with the CPI for which projections are available. The relationship between the change in the marketing cost index and the change in the CPI with quarterly dummy variables (significant for the second and third quarters) and assuming a first order serial correlation process, is:

$$\begin{array}{lllll} DQMCOST = 3.60*DCPIUS & - 2.49*Q2 & - 2.96*Q3 & - 0.27*Q4 \\ \quad\quad\quad (12.00) & (-3.88) & (-4.26) & (-0.45) \end{array}$$

This model had an R^2 of 0.64 and a D-W statistic of 2.03. All coefficients with the exception of Q4 were significant. The projected levels of the index from the second quarter 1991 until the third quarter 1992 from the model above are 407.2, 411.6, 416.3, 418.8 and 420.9. These were calculated after differencing the projected levels of the CPI from above.

Alternatively, projections for the marketing cost index could be derived by assuming that it grows at the same rate as the CPI.

Projections for the New York eggs price series are taken from the USDA publication Livestock and Poultry Situation and Outlook Report. The projected price (Lawrence Witucki, USDA, personal communication) for the third and fourth quarters of 1991 were 78 and 82. The projected price range for the first quarter of 1992 and for all of 1992 were 75-81 and 73-79. The projections used here for the first, second and third quarters of 1992 were 78, 76 and 76 cents per dozen based on the midpoint of the range.

As yet, a published source of projections of the Minnesota-Wisconsin 3.5% milk price has not been identified. (The USDA makes a projection for the "all milk" price and this is published in World Agricultural Supply and Demand Estimates.) At present, Dr. Geoff Benson's (personal communication) projections for this price are being used. His projections for the last two quarters of 1991 and the first three quarters for 1992 are $11.40, $11.67, $10.25, $10.58 and $12.08 per cwt.

All price projections were made from the models estimated using data up to the second quarter 1991 and projected values of exogenous variables up to the third quarter 1993 using a dynamic forecasting procedure.

Egg Models

The full and reduced models for retail egg prices are presented in Table 2. Recall that the variables and mnemonics used in this table are defined in Table 1. Both these models were estimated with a correction for first order serial correlation, but unlike the milk and cheese models, there was no need to difference the price series because there was no consistent upward trend in egg prices.

Both models have high explanatory powers, their residuals are well behaved, and they make few turning point errors. The reduced model was preferred because of its simplicity. The likelihood ratio test statistic, λ, was 2.88, which means that we fail to reject the null hypothesis that the coefficients for the omitted variables are zero. The model based on the farm price of eggs in North Carolina also performed well.

Table 2. Egg models

Dependent Variable: RUSEGG - retail price of U.S. eggs in cents per dozen

	Full model		Reduced model	
Variable	Coefficient	T-stat	Coefficient	T-stat
C	8.32	2.1*	9.28	3.5*
Q2	-0.36	-0.4	-0.39	-0.5
Q3	-0.77	-0.7	-0.89	-1.0
Q4	-1.86	-2.3*	-1.91	-2.5*
NYEGGS	0.87	17.8*	0.88	19.0*
NYEGGS(-1)	0.25	5.2*	0.25	5.5*
QMCOST	0.06	0.3		
QMCOST(-1)	-0.06	-0.3		
CPIUS	0.02	0.0		
CPIUS(-1)	-0.03	-0.0		
R^2	0.97	0.96		
D-W	1.97	1.97		
LLF	-108.22	-106.78		
Q	19.9	19.3		
RMSE	1.86	1.89		
THEIL	0.02	0.02		
TPEs	2	2		

*Statistically significant

SOURCES: See Appendix 2.

The reduced model says that retail egg prices are explained largely by the New York wholesale egg price. It takes more than one quarter for retail prices to adjust fully to a change in the wholesale price. If the price of New York eggs rose by a cent a dozen, then retail price would rise by 0.88 cents in the same quarter and by a further 0.25 cents in the next quarter. If the price of New York eggs remained unchanged, then the retail price of eggs would fall by about two cents per dozen in the fourth quarter because of seasonal effects. The elasticities of retail price with respect to a change in the price of New York eggs were 0.71 and 0.91 in the short and long runs.

Projections for the retail price of eggs until the third quarter of 1992 can be found in Table 3. The projections from both models are almost the same. The retail price of eggs was expected to rise until the end of 1991 and then to fall for the first three quarters of 1992 in line with

Table 3. Egg price projections

Year/ quarter	Full model		Reduced model	
	RUSEGG[a]	CI[b]	RUSEGG	CI
A: Projected price of U.S. retail eggs - cents/dozen				
1991:3	94.29	5.23	94.32	4.63
1991:4	98.82	5.29	98.74	4.63
1992:1	98.22	5.31	98.13	4.62
1992:2	94.98	5.31	94.99	4.67
1992:3	94.05	5.38	94.00	4.68
B. Percent change in egg prices in each quarter				
1991:3	1.3		1.3	
1991:4	4.8		4.7	
1992:1	-0.6		-0.6	
1992:2	-3.3		-3.2	
1992:3	-0.9		1.0	

[a]RUSEGG: Retail price of U.S. eggs in cents/dozen.
[b]CI: 95 percent confidence interval in cents/dozen.

SOURCES: See Appendix 2.

changes in the projected price of New York eggs. The table reports a 95% confidence interval of about five cents. This means that in the third quarter of 1991 for example, the probability that the actual retail price will fall in the range from 89.06 to 99.52 cents per dozen is 95%. The percentage changes in retail price from one quarter to the next are also detailed in Table 3. The percentage change in price for the year beginning in the fourth quarter 1991 and ending in the third quarter 1992 is expected to be a fall of about 0.3 percent, but during the year there is a sharp rise in price in the fourth quarter 1991 and a sharp fall in the second quarter of 1992.

Fresh Milk Models

The full and reduced models for fresh whole milk are presented in Table 4. Since 1978 there has been a strong upward trend in milk and cheese prices, and the Durbin-Watson statistics for the milk and cheese models estimated in levels were close to one. Hence, for both the milk and cheese models, the price variables were differenced, which means that the models explain the change in the retail price (rather than the level of the retail price) in terms of changes in the prices of farm and processing inputs. Even after differencing, there appeared to be a serial correlation problem. Both the milk and cheese models were estimated with a correction for first order serial correlation.

Both the full and reduced milk models have high explanatory powers and first order serial correlation is no longer a problem. The reduced model has been preferred because its residuals appear to be better behaved (Q = 23.3), it makes fewer turning point errors, and the likelihood ratio test statistic is only 2.7. In the reduced model, the marketing cost index has been preferred to the CPI variable as a measure of processing costs largely because there appears to be less autocorrelation among the residuals in this model.

In the reduced model there is a positive seasonal effect in the fourth quarter and lagged farm milk price and current period marketing costs are also important in explaining changes in the CPI for milk. The CPI is likely to be 4.5 points higher in the fourth quarter. An increase of $1 per cwt in the MW35 price is expected to lead to an increase of 0.02 points in the current quarter and 0.25 points in the next quarter in the

Table 4. Milk models

Dependent Variable: CPIFWM - The CPI for retail price of fresh whole milk in first difference terms

Variable	Full model		Reduced model	
	Coefficient	T-stat	Coefficient	T-stat
Q2	-0.08	0.0	2.50	1.2
Q3	-2.42	-0.6	2.21	1.0
Q4	2.55	0.8	4.51	2.0*
DMW35	0.03	1.7	0.02	1.4
DMW35(-1)	0.25	12.7*	0.25	13.9*
DQMCOST	0.14	0.2	0.79	1.8*
DQMCOST(-1)	-0.23	-0.4	0.50	1.2
DCPIUS	4.87	1.8*		
DCPIUS(-1)	0.94	0.4		
R^2	0.89		0.89	
D-W	1.96		2.09	
LLF	-171.22		-172.57	
Q	28.70		23.30	
RMSE	6.50		6.67	
THEIL	0.30		0.31	
TPEs	9		7	

*Statistically significant.

SOURCES: See Appendix 2.

CPI for fresh whole milk. Similarly, an increase in the marketing cost index of one point results in increases in the milk CPI of 0.79 and 0.50 points in the current and next quarters. The long-run elasticity of retail milk price with respect to a change in farm price is 0.31, and with respect to a change in marketing costs, it is 0.43.

Projections for the retail price of fresh whole milk can be found in Table 5. The projected changes in the level of the CPI for milk are presented in part A of the Table. It is perhaps easier to think of precentage changes in retail milk prices and these are presented in Part B. Over the twelve months from the start of the fourth quarter 1991 to the end of the third quarter 1992, retail milk prices are expected to rise by

Table 5. Milk price projections

Year/ quarter	Full Model		Reduced Model	
	CPIFWM[a]	CI[b]	CPIFWM	CI
	A: Projected change in level of milk CPI			
1991:3	13.92	54.25	10.49	53.92
1991:4	39.62	53.91	37.92	53.91
1992:1	9.99	53.61	9.53	53.78
1992:2	-26.93	53.98	-28.02	54.14
1992:3	17.65	54.22	16.70	54.47
	B: Percent change in retail milk price in each quarter			
1991:3	1.1		0.9	
1991:4	3.2		3.1	
1992:1	0.8		0.8	
1992:2	-2.1		-2.2	
1992:3	1.4		1.3	

[a]CPIFWM: CPI for fresh whole milk.
[b]C.I.: 95 percent confidence interval for the change in the level of CPIFWM.

SOURCES: See Appendix 2.

2.9%, but during the year there is a sharp rise in fourth quarter 1991 and a sharp fall in the second quarter 1992. The 95 percent confidence interval covers a range of about 4.5 percent on either side of these projected percentage changes. These projections are from the preferred reduced model.

Cheese Models

The full and reduced models for the retail price of cheese are presented in Table 6. As mentioned above, these models were estimated after differencing the price series and correcting for first order serial correlation. Again, the reduced model from which the marketing cost index variables have been omitted is preferred to the full model. It makes fewer turning point errors and has better behaved residuals than the full model, and the likelihood ratio statistic is 5.30. Both cheese models make more turning point errors than the milk and egg models and the explanatory power is perhaps less than desirable.

Seasonal effects are not important in the cheese models, but because of the extent of processing involved in cheese-making, changes in milk prices and processing costs take up to two quarters to be fully reflected in price changes at the retail level. Hence, an increase of $1 in the MW35 price causes changes of 0.10, 0.14 and 0.05 in the level of the retail CPI for cheese in the current and next two quarters. Similarly, a one-unit change in the level of the CPI causes increases in the cheese CPI of 4.02 in the current quarter and 4.85 units two quarters from now. There is no significant change in the next quarter. This explanation of how changes in input prices affect the retail price is a literal interpretation of the model. The reader should place more credence on the size of the effects and on the fact that lags in adjustment in the cheese industry may be quite lengthy rather than on the exact timing of these effects. The long-run elasticity of retail cheese price with respect to a change in the farm price of milk is 0.33; with respect to a change in marketing costs (here the CPI), the elasticity of retail price is 0.74.

Projections for the retail price of cheese can be found in Table 7. The projected changes in the level of the CPI for cheese are presented in Part A of the table. As for milk, it is perhaps easier to think of percentage changes in retail cheese prices and these are presented in

Table 6. Cheese models

Dependent Variable: CPICH - CPI for retail price of cheese in first difference terms.

Variable	Full model Coefficients	Full model T-stat	Reduced model Coefficients	Reduced model T-stat
Q2	0.60	0.2	-0.64	-0.2
Q3	1.13	0.3	2.47	0.6
Q4	-2.44	-0.7	1.36	0.5
DMW35	0.11	5.5*	0.10	4.9*
DMW35(-1)	0.14	6.7*	0.14	6.9*
DMW35(-2)	0.04	2.0	0.05	2.3*
DQMCOST	-0.06	-0.1		
DQMCOST(-1)	-1.01	-1.4		
DQMCOST(-2)	-1.62	-2.4*		
DCPIUS	6.43	2.2 *	4.02	1.8*
DCPIUS(-1)	2.66	0.9	-1.53	-0.7
DCPIUS(-2)	6.73	3.2*	4.85	2.5*
R^2	0.75		0.72	
D-W	1.94		1.89	
LLF	-168.05		-171.70	
Q	15.60		13.30	
RMSE	6.52		6.99	
THEIL	0.34		0.37	
TPEs	16		13	

*Statistically significant.

SOURCES: See Appendix 2.

Part B. Over the twelve months from the start of the fourth quarter 1991 to the end of the third quarter 1992, retail cheese prices are expected to rise by 3.9%, but during the year there is a sharp rise in fourth quarter 1991, followed by stable prices in the next two quarters and then a further rise in the third quarter 1992. The 95% confidence interval covers a range of about 4.8% on either side of these projected percentage changes. These projections are from the preferred reduced model.

Conclusions

Retail food prices fluctuate in response to a variety of factors inherent in the production and consumption of agricultural products. These include the effects of weather, changes in farm programs, cyclical changes in livestock production, and changes in on-farm production costs;

Table 7. Cheese price projections

Year/ quarter	Full model		Reduced model	
	CPICH[a]	CI[b]	CPICH	CI
A: Projected change in level of cheese CPI				
1991:3	34.70	60.46	25.63	62.87
1991:4	33.80	59.49	28.09	62.83
1992:1	8.79	58.89	6.73	62.82
1992:2	-5.54	58.53	-6.70	62.48
1992:3	27.34	59.19	24.61	62.97
B: Percent change in retail cheese price in each quarter				
1991:3	2.6		1.9	
1991:4	2.5		2.1	
1992:1	0.6		0.5	
1992:2	-0.4		-0.5	
1992:3	1.2		1.8	

[a]CPICH: CPI for the retail price of cheese.
[b]CI: 95 percent confidence interval for the change in the level of the CPI for cheese.

SOURCES: See Appendix 2.

changes in processing, distribution and retailing costs; and changes in the number of consumers, their purchasing power and their preferences.

While retail food prices fluctuate throughout the year, the federal appropriation for the WIC program is fixed within any year. Adjustments in program participation must be made throughout the year based on the budget allocation and the expected retail prices of WIC eligible food items.

The objectives of this project were (a) to develop models for forecasting North Carolina annual retail prices for fluid milk, cheese and eggs and (b) to provide price forecasts on a biannual basis to assist managers of the North Carolina WIC program budget.

The methodology involved estimating relationships that allow forecasts of changes in the retail prices of milk, cheese and eggs in terms of the farm prices of these commodities and the cost of processing them. The models are based on quarterly observations, which allows an examination of whether retail prices are influenced by seasonal factors. Because retail prices may not fully respond to changes in farm prices or processing costs within the same quarter, the models generally include farm and processing prices from one or two of the previous quarters. Forecasting retail prices also requires that forecasts be made of farm and processing prices. The USDA routinely issues price projections for selected farm products, but this is not the case for retail products. Our forecasting models are based on average U.S. prices or on the prices in major indicator markets. The assumption underlying this approach is that price movements in North Carolina will closely reflect what is happening in the rest of the United States.

The criteria used in choosing from alternative forecasting models include the availability of an historical series on prices and the availability of projections on the prices of the farm and processing inputs. The other important criterion on which to discriminate between models is their forecasting ability. Obviously the ability of a model to forecast cannot be measured until after the event. Hence, models usually are assessed on the basis of how well they explain past behavior of the price series being forecast. The usual statistical measures of how well a model explains behavior have been applied in this study.

Price projections from the favored forecasting models for five quarters from third quarter 1991 are presented in Table 8. These projections are the predicted percentage changes in retail prices from one quarter to the next. The projections presented here are point estimates. A projected range within which we expect prices to fall with a greater degree of confidence can be found in the main part of this report.

Table 8. Projected changes in retail prices for eggs, milk and cheese

Year/ quarter	Eggs (%)	Milk (%)	Cheese (%)
1991:3	31.3	0.9	1.9
1991:4	4.7	3.1	2.1
1992:1	-0.6	0.8	0.5
1992:2	-3.2	-2.2	-0.5
1992:3	1.0	1.3	1.8

The retail price of eggs is expected to rise until the end of 1991 and then to fall for the first three quarters of 1992 in line with changes in the projected price of New York eggs. The percentage change in price for the year beginning in the fourth quarter 1991 and ending in the third quarter 1992 is expected to be a fall of about 0.3%. The confidence interval surrounding these projections is 4.9%.

Over the twelve months from the start of the fourth quarter 1991 to the end of the third quarter 1992, retail milk prices are expected to rise by 2.9%, but during the year there is expected to be a sharp rise in fourth quarter 1991 and a sharp fall in the second quarter 1992. The confidence interval surrounding these projections is 4.5%.

Over the twelve months from the start of the fourth quarter 1991 to the end of the third quarter 1992, retail cheese prices are expected to rise by 3.9%. During the year there is expected to be a sharp rise in the fourth quarter 1991, followed by stable prices in the next two quarters, and then a further rise in the third quarter 1992. The 95 percent

confidence interval covers a range of about 4.8% on either side of these projected percentage changes.

References

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APPENDIX 1

Price Data for Selected Variables

Appendix 1, Table 1. Price data for MW35, CPIFM and CPICH, 1978:1-1991:2

Year/quarter	MW35	CPIFWM	CPICH
1978:1	900.00	742.33	691.67
1978:2	925.00	762.33	707.00
1978:3	963.67	774.33	721.33
1978:4	1040.67	801.67	750.67
1979:1	1055.33	831.00	779.33
1979:2	1068.67	843.00	796.00
1979:3	1109.33	864.33	813.00
1979:4	1128.67	895.67	836.33
1980:1	1143.67	911.00	850.67
1980:2	1167.33	930.00	873.67
1980:3	1188.67	940.00	896.33
1980:4	1251.67	958.33	927.67
1981:1	1266.00	983.00	952.00
1981:2	1260.00	989.33	962.33
1981:3	1248.67	988.33	963.67
1981:4	1256.33	990.00	965.67
1982:1	1248.67	993.00	977.00
1982:2	1243.33	995.00	983.67
1982:3	1244.00	992.00	987.00
1982:4	1258.00	992.00	990.33
1983:1	1258.00	1002.33	995.33
1983:2	1250.67	1001.00	1002.00
1983:3	1248.67	999.33	1004.67
1983:4	1239.67	996.00	1004.33
1984:1	1206.67	1000.00	1004.67
1984:2	1208.00	1001.33	1004.67
1984:3	1237.00	1003.33	1016.33
1984:4	1262.67	1024.33	1026.67
1985:1	1218.67	1030.33	1031.00
1985:2	1143.00	1026.33	1028.33
1985:3	1110.00	1020.67	1035.67
1985:4	1119.33	1014.67	1033.67
1986:1	1106.33	1012.33	1032.67
1986:2	1098.67	1012.33	1031.67
1986:3	1131.33	1015.67	1037.00
1986:4	1183.00	1028.00	1041.00
1987:1	1133.33	1033.33	1052.67
1987:2	1102.33	1031.00	1056.67
1987:3	1129.33	1032.33	1060.33
1987:4	1127.00	1049.00	1068.00

Appendix 1, Table 1 (continued).

Year/quarter	MW35	CPIFWM	CPICH
1988:1	1064.67	1049.67	1077.33
1988:2	1033.67	1048.67	1079.67
1988:3	1099.33	1055.67	1092.00
1988:4	1212.67	1087.33	1120.67
1989:1	1138.00	1126.00	1139.33
1989:2	1118.00	1123.67	1145.67
1989:3	1241.00	1129.00	1169.33
1989:4	1448.67	1192.00	1248.00
1990:1	1272.33	1274.00	1296.00
1990:2	1279.33	1246.67	1292.67
1990:3	1300.67	1266.00	1324.33
1990:4	1030.67	1280.00	1334.00
1991:1	1007.33	1224.67	1324.00
1991:2	1025.67	1214.33	1318.00

SOURCES: See Appendix 2.

Appendix 1, Table 2. Price data for NYEGGS, RUSEGG, QMCOST, and CPIUS, 1978:1-1991:2

Year/quarter	NYEGGS	RUSEGG	QMCOST	CPIUS
1978:1	62.00	76.90	221.10	62.93
1978:2	53.80	71.17	224.40	64.53
1978:3	63.07	79.00	228.40	66.07
1978:4	67.83	80.83	234.20	67.40
1979:1	71.87	88.90	240.80	69.07
1979:2	66.07	82.90	247.40	71.47
1979:3	65.23	81.87	254.90	73.83
1979:4	69.43	84.50	265.60	75.93
1980:1	62.10	83.10	274.60	78.93
1980:2	58.13	75.47	283.40	81.83
1980:3	70.27	86.97	289.60	84.03
1980:4	76.87	93.23	297.30	85.77
1981:1	72.63	91.57	308.10	87.80
1981:2	69.10	86.73	316.30	89.83
1981:3	73.27	89.10	322.50	92.37
1981:4	77.80	95.13	323.00	93.70
1982:1	79.43	97.23	330.10	94.47
1982:2	66.70	86.03	332.90	95.90
1982:3	65.80	84.73	335.20	97.70
1982:4	68.43	86.07	336.60	97.93
1983:1	65.83	84.80	339.30	97.87
1983:2	69.03	86.53	341.10	99.10
1983:3	74.43	92.07	344.10	100.27
1983:4	91.30	104.83	347.50	101.17
1984:1	103.33	127.03	353.20	102.30
1984:2	83.43	106.83	356.10	103.40
1984:3	70.03	88.30	357.00	104.53
1984:4	66.63	87.63	358.70	105.30
1985:1	61.70	77.33	359.00	105.97
1985:2	60.00	75.07	358.80	107.27
1985:3	67.83	81.13	357.40	108.03
1985:4	75.90	87.93	359.70	109.00
1986:1	74.13	88.47	357.60	109.23
1986:2	63.37	83.50	354.60	109.00
1986:3	72.80	87.13	352.90	109.80
1986:4	74.10	88.73	354.40	110.40
1987:1	64.77	82.83	357.30	111.63
1987:2	58.90	75.33	359.50	113.10
1987:3	63.53	77.67	361.30	114.40
1987:4	59.20	77.13	363.40	115.37
1988:1	55.00	73.93	366.90	116.07
1988:2	53.27	70.07	370.80	117.53
1988:3	72.90	86.20	372.60	119.10
1988:4	67.23	85.60	376.00	120.33

Appendix 1, Table 2 (continued).

Year/quarter	NYEGGS	RUSEGG	QMCOST	CPIUS
1989:1	78.43	95.40	381.80	121.67
1989:2	75.17	96.33	383.90	123.67
1989:3	81.50	99.40	385.10	124.67
1989:4	92.60	108.00	388.30	125.87
1990:1	87.83	112.50	393.40	128.03
1990:2	74.63	98.73	393.90	129.33
1990:3	77.80	93.30	397.00	131.57
1990:4	88.50	101.03	405.50	133.70
1991:1	85.90	105.40	405.70	134.80
1991:2	70.23	93.13	405.80	135.60

SOURCES: See Appendix 2

Appendix 1, Table 3. Statistics for selected variables. (Number of observations = 54)

Variable	Mean	Standard deviation	Minimum	Maximum	Sum	Variance
NYEGGS	71.13	10.15	53.27	103.33	3841.10	102.96
MW35	1162.10	104.69	900.00	1448.67	62753.3	10960.43
QMCOST	336.78	50.49	221.10	405.80	18186.00	2549.56
CPIUS	102.42	19.69	62.93	135.60	5530.57	387.52
RUSEGG	88.53	10.95	70.07	127.03	4780.77	119.96
CPIFWM	1015.33	122.35	742.33	1280.00	54828.00	4969.88
CPICH	1017.66	156.88	691.67	1334.00	54953.67	24611.12

APPENDIX 2

Data Sources

RUSEGG: The retail price of U.S. eggs is from Table P-4, "Average Retail Food Prices: U.S. City Average and Four Regions," in the BLS publication CPI Detailed Report, 1978-1991.

CPIFWM, CPICH, CPIUS: The CPIs for fresh whole milk and for cheese CPICH and for all items are from Table 3, "CPI for CPIUS All Urban Consumers: Detailed Expenditure Categories, U.S. City Average," in the BLS publication CPI Detailed Report, 1978-1991.

NYEGGS: The price series for New York eggs is from USDA, Livestock and Poultry: Situation and Outlook Report, 1978-1991.

MW35: The price series for Minnesota-Wisconsin manufacturing milk with 3.5% butterfat is from USDA, Dairy Market News, 1978-1991.

QMCOST: Food marketing cost indexes are from Table 9, "Price Indexes of Food Marketing Costs" in USDA, Agricultural Outlook, 1978-1991.

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