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A Quarterly Forecasting Model for the Consumer Price Index for Food

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A model is developed to forecast the food price component of the consumer price index published by the Bureau of Labor Statistics. The model relates retail food prices to prices received by farmers and to wage rates in food marketing industries. The farm value and farm-retail spread of the market basket are used as intermediate variables in transmitting the effect of these variables to prices of food at home and all food. A system of equations structured along the lines of the USDA market basket is presented along with a set of reduced form forecasting equations.

Key words: Food prices, farm prices, farm-retail spreads, forecasts.

With the recent upsurge of concern over the consumer price index (CPI)—particularly its second largest component, food—the current state of knowledge regarding forecasting and explanation of the CPI for food has come under serious examination. Although some price forecasting models were available, they were not readily adaptable to current operating procedures within the Economic Research Service, which has primary responsibility for food price forecasts.[1] As a result, past forecasts have been largely based on procedures which aggregate the forecasts by individual commodity analysts into an estimate of the price level for all food. These procedures usually reflect changes in the supply situation for the individual commodities but tend to overlook some of the interrelationships among commodities, the influence of demand on marketing charges, and the overall effect of demand on the aggregate food price index. In defense of this approach, it must be recognized that the conceptualization of these latter influences on the CPI for food into a formal statistical model is a reaction to the current problematical situation which has developed.

The objective of the system of equations which we have specified is to utilize readily available forecasts of exogenous variables to generate a series of quarterly forecasts of food-price indexes with a premium placed on speed of computation and accuracy. A completely rigorous theoretical structure was not built into the model, but a system of equations is provided and the short- and long-run impact multipliers are presented. These are useful in determining the combined direct and indirect effects of changes in the exogenous variables on the endogenous variables.

The basic goal of the model, namely forecasting the retail price index for food given levels of farm prices and marketing costs, is somewhat like going upstream against the traditional current of consumer demand which flows through the marketing system and comes to rest at the farmer's gate as a derived demand. But for a quarterly period, it is the supply curve that shifts and the market prices adjust to clear the market at the farm level. These farm price changes are then passed along to consumers.

After a general outline of the model, we discuss the equations and their roles in the system. An appraisal of the accuracy of the model over a historical period, tests of the model for a recent interval outside the historical period, and forecasts are presented.

General Structure of the Model

The system of equations is closely related to the concept of the USDA market basket.[2] The retail value of this basket of farm foods is composed of a farm value which measures the payment to farmers for the raw materials equivalent to the food purchased by consumers, and a farm-retail spread which closely approximates costs of assembling, processing, transporting, and distributing the farm food products. The market basket is made up of a constant quantity of different foods, so the variations in the retail cost, farm value, and farm-retail spread are essentially price variations. Care is taken to assure consistency between retail and farm

[1] For example, see: Jimmy L. Matthews. Forecasting the Quarterly Retail Food Price Index. Natl. Food Situation, May 1967.

[2] See: Forrest E. Scott and Henry T. Badger. Farm-Retail Spreads for Food Products. U.S. Dept. Agr., Misc. Pub. 741, Jan. 1972.

levels so that differential movements accurately measure changes in the spread between retail and farm prices. Because of these adjustments, the changes in the farm value of the market basket which are more relevant for our forecasts of retail food prices often differ from changes in USDA's Index of Prices Received by Farmers. The latter also includes nonfood commodities, such as cotton, tobacco, and feed grains.

The model is a quasi-recursive system structured along the lines of the market basket, with the indexes of prices received by farmers for various farm products used to estimate the farm values of the crop and livestock food groups. These estimates are then combined with other equations which estimate the farm-retail spreads for the groups, to estimate the food-at-home component of the consumer price index. Finally, the all-food index, which includes food eaten away from home, is estimated.

The treatment of the crop and livestock components is not entirely symmetric (fig. 1). The recursive aspects of the model which are evident for crop foods are absent in the livestock subsector, where some feedback from the consumer market to the farm level for livestock products is found.

There is an implicit consumer market for crop foods consumed at home which provides the setting for price determination in the food crops subsector. Within this general environment, the farm value of crops and the farm-retail spread are determined simultaneously in the system but without any direct link to the general level of food prices. Once the farm value and farm retail spread are determined, they are fed recursively into the mechanism for estimating the CPI for food at home.

For livestock food products, there is again an implicit market environment, but this time a direct link exists between the farm value and the food-at-home price level. As a result, the farm value and the farm-retail spread for livestock products are estimated simultaneously in the system along with the total food-at-home index.

The difference in structure for the two product groups has no strong theoretical basis.[3] It is based mainly on the statistical results supported by the data. Certain characteristics of the market for each group are examined later as possible explanations of this difference in price-determining influences.

The System of Structural Equations

The following equations were estimated by two-stage least squares (TSLS), utilizing quarterly data from the first quarter of 1960 to the third quarter of 1971. The numbers in parentheses are t values; *D.W.* is the Durbin-Watson statistic.

1. Farm value of crop foods:

$$FVC_t = 49.7960 + \underset{(2.32)}{0.4644}\, FRSC_t - \underset{(-0.09)}{0.0266}\, FRSC_{t-1} - \underset{(-1.52)}{0.3596}\, FRSC_{t-2} + \underset{(2.04)}{0.0964}\, PRO_t + \underset{(4.46)}{0.1155}\, PRF_t + \underset{(6.03)}{0.2696}\, PRV_t - \underset{(-7.16)}{7.3816}\, DWS_t - \underset{(-5.19)}{4.9629}\, DWA_t$$

$$R^2 = 0.924 \qquad D.W. = 1.25$$

2. Farm-retail price spread for crop foods:

$$FRSC_t = 63.9108 - \underset{(-3.25)}{0.1442}\, FVC_t + \underset{(1.39)}{0.0718}\, FVC_{t-1} - \underset{(-2.48)}{0.1150}\, FVC_{t-2} - \underset{(-1.00)}{0.0104}\, FVC_{t-3} + \underset{(27.70)}{0.5570}\, WFMI_t + \underset{(2.99)}{1.3053}\, DSQ_t + \underset{(5.42)}{2.2857}\, DTQ_t$$

$$R^2 = 0.984 \qquad D.W. = 1.440$$

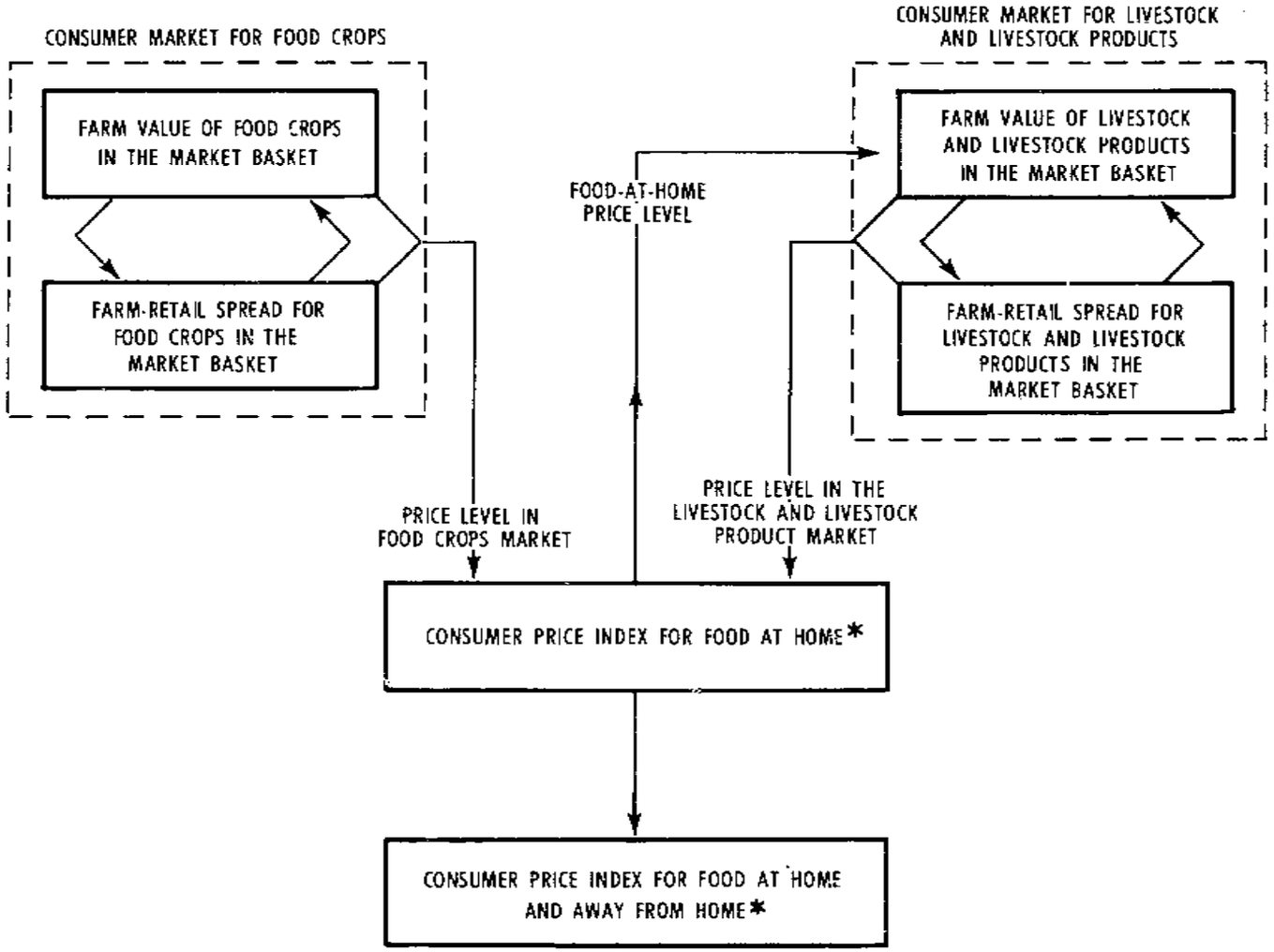
3. Farm value of livestock food products:

$$FVL_t = 17.1637 - \underset{(-5.13)}{0.3966}\, FRSL_t + \underset{(2.15)}{0.2335}\, CPIF_t + \underset{(18.74)}{0.6115}\, PRM_t + \underset{(6.75)}{0.2346}\, PRD_t + \underset{(8.72)}{0.1528}\, PRP_t - \underset{(2.52)}{0.9064}\, DFQ_t$$

$$R^2 = 0.991 \qquad D.W. = 1.203$$

[3]The term "structure" is used to differentiate this set of equations from the "reduced forms" later in the article.

DETERMINATION OF FOOD PRICES



* Bureau of Labor Statistics

Figure 1

4. Farm-retail price spread for livestock food products:

$$FRSL_t = 14.5147 - \underset{(-6.40)}{0.3685}\, FVL_t + \underset{(3.71)}{0.2357}\, FVL_{t-1} + \underset{(3.84)}{0.2042}\, FVL_{t-2} + \underset{(13.19)}{0.9299}\, WFMI_{t-1} - \underset{(-6.55)}{0.4690}\, T_t + \underset{(3.31)}{1.9842}\, D4Q_t$$

$R^2 = 0.969$ $\quad D.W. = 2.045$

5. Consumer price index for food consumed at home:

$$CPIF_t = 3.40227 + \underset{(20.05)}{0.2253}\, FVL_t + \underset{(7.08)}{0.1535}\, FVC_t + \underset{(10.96)}{0.3656}\, FRSL_t + \underset{(6.06)}{0.2758}\, FRSC_t + \underset{(2.83)}{0.0545}\, T_t$$

$R^2 = 0.997$ $\quad D.W. = 1.441$

6. Consumer price index for all food:[4]

$$TCPIF_t = -9.05481 + \underset{(46.42)}{1.08233}\, CPIF_t + \underset{(1.49)}{0.02202}\, T_t$$

$R^2 = 0.998$ $\quad D.W. = 0.768$

$$CPIF_t^* = CPIF_t - 0.9592\, CPIF_{t-1}$$

$$T_t^* = T_t - 0.9592\, T_{t-1}$$

$$TCPIF_t^* = TCPIF_t - 0.9592\, TCPIF_{t-1}$$

$$TCPIF_t^* = 0.2913 + \underset{(33.81)}{0.7804}\, CPIF_t^* + \underset{(8.33)}{0.4047}\, T_t^*$$

$R^2 = 0.9998$ $\quad D.W. = 2.159$

[4]This set of equations reflects the first order autoregressive adjustments necessary to correct for serial correlation bias which was evident in the first specifications of the all food index presented above. 0.9592 is the estimate of b in $U_t = bU_{t-1}$ where U_t and U_{t-1} are the observed residuals in the first equation.

Definition of variables:

FVL_t = Farm value of livestock food products, market basket, index (1967 = 100).[5]
FVC_t = Farm value of crop food products, index.
$FRSL_t$ = Farm-retail spread for livestock food products, index. Difference between the retail cost and farm value.
$FRSC_t$ = Farm-retail spread for food crop products, index.
$CPIF_t$ = Consumer price index for food at home (Bureau of Labor Statistics series).
$CPIF_t^*$ = Adjusted consumer price index, food at home.
$TCPIF_t$ = Consumer price index for all food (Bureau of Labor Statistics series).
$TCPIF_t^*$ = Adjusted consumer price index for all food.
PRM_t = Prices received by farmers for meat animals (Statistical Reporting Service series), index.[6]
PRD_t = Prices received by farmers for dairy products, index.
PRP_t = Prices received by farmers for poultry and eggs, index.
PRO_t = Prices received by farmers for oil products, index.
PRF_t = Prices received by farmers for fruits, index.
PRV_t = Prices received by farmers for vegetables, index.
DFQ_t = Dummy variable, value of one for the first quarter.
DSQ_t = Dummy variable, value of one for the second quarter.
DTQ_t = Dummy variable, value of one for the third quarter.
$D4Q_t$ = Dummy variable, value of one for the fourth quarter.
DWS_t = Dummy variable, value of one for the years of wheat subsidies, 1960-64.
DWA_t = Dummy variable, value of one for the years of high effective national wheat allotments, 1967-68.

[5]This farm value is calculated by multiplying the price the farmer receives for the corresponding farm product by the quantity of a farm product equivalent to one unit of product at retail. The current market basket contains the average quantities of domestic farm-originated foods purchased annually per household in 1960-61 for preparation at home by families of urban wage earners and clerical workers and workers living alone. All indexes are on a base of 1967 = 100. They are published quarterly in the Marketing and Transportation Situation.

[6]Current data are published in Agricultural Prices, by USDA's Statistical Reporting Service. Indexes on a 1910-14 base were converted to 1967 reference base. See Agricultural Prices, Sup. 2, June 1970, for conversion factors.

$WFMI_t$ = Hourly wages in the food marketing industry, index.[7]

T_t = Time trend variable with $T = 1$ in first quarter 1960.

Lagged variables are identified by a subscript $t\text{-}i$ which means the variable has been lagged i quarters. Symbols for lagged variables are the same as for current variables defined above.

Crop foods. The crop foods system is a system which feeds a price level for food crops into the retail market but receives no direct price level feedback from that market, apparently relying almost totally on cost factors for spread determination and feedback. This result, although not completely consistent with the theory of derived demand, does reflect the nature of the market. While the farm value of crop foods constitutes only about 20 percent of the total farm value in the market basket, the farm-retail spread for crop foods constitutes about 50 percent of the total spread in the market basket. In addition the farm-retail spread accounted for almost 80 percent of the total retail value of crop foods in the market basket.[8] Thus the key element in this system is the farm-retail spread, which is basically a measure of cost plus profit. Changes in farm-retail spreads in the long run are determined mainly by changes in costs of all factors involved in processing and distribution.

The coefficients on the indexes of prices received by farmers for oil crops, fruit, and commercial vegetables appear to be roughly in line with their respective importance in the market basket. The farm price of grain does not appear explicitly because it was not a statistically significant variable. However, dummy variables, DWS_t and DWA_t, were included. These are designed to identify significant changes in grain programs which affected price. In particular, DWS_t identifies the period 1960-64 for which wheat subsidy programs were in effect, while DWA_t identifies the periods of abnormally high effective wheat allotments in 1967-68.

The farm-retail spread equation reflects the cost concept of the spread as well as the lagged adjustment with respect to the farm value. But in this equation a rise in the farm value initially depresses the farm-retail spread contrary to the relationship found in the farm value equation. This negative relationship may be explained in terms of the imperfections of the market in adjusting to short-term changes. The negative relationships for the lagged farm value represent the other side of the derived-demand coin; now the increase in the price of the raw farm product depresses the relative price of the other input, namely marketing services.

Labor costs in marketing are reflected in the wages variable, $WFMI_t$, which is a weighted average of wages in the (1) manufacturing, (2) wholesaling, and (3) retailing phases of the food industry.[9] Since wage levels in food marketing move closely with wages in the rest of the economy, this variable may also provide a link with the price and cost levels outside the food sector. The current wage level was highly significant in this equation, the only equation in which it was important. In other equations, the lagged wage was the key element. This may be partly explained by the nature of the crop products group. Bakery and cereal products have a more extensive process of manufacturing and a higher labor cost component than most food products. Additionally, labor costs make up a substantial portion of retail and wholesale gross margins for fresh fruits and vegetables. Thus it is not surprising that fresh and processed fruits and vegetables, which have the largest total farm-retail spread of any group of products in the market basket, should dictate a major role for labor costs in determining the farm-retail spread.

The dummy variables in the spread equation for crop foods play an important role. Earlier studies had indicated that the spread and farm value of the crop foods moved very much together, whereas the farm value and spread equations presented here are not completely in agreement. The correlation between the two components apparently is a second- and third-quarter seasonality phenomenon inherent in the crop foods system. The seasonal rise in the spread can be partly attributed to seasonally short supplies, greater transportation costs for fresh produce, and accumulated storage costs for some items during those periods.

Livestock food products. The system for livestock food products reflects very different relationships to the total food market. The key is the importance of this product group in the total farm food sector. About 80 percent of the total farm value of the market basket is attributed to livestock products. At the same time, livestock products represent about 50 percent of the total market basket farm-retail spread. This system, in contrast to the crop food system, is certainly not as strongly oriented to marketing costs. Since the farm value of livestock foods accounts for 89 percent of the total farm value, it was expected that any feedback from the total retail level to the farm level would be likely to show up in the livestock sector.

[7] See Marketing and Transportation Situation, July 1972, p. 2.

[8] These figures are based on 1967 market basket information.

[9] See page 13 of reference cited in footnote 1.

The farm value equation provides the key link between the food price index and the livestock products group. Since food prices tend to be closely related to the general price level, this variable also reflects the general demand conditions in the economy. The coefficients on the indexes of prices received for meat animals, dairy products, and poultry and eggs are roughly consistent with their importance in the farm value of the market basket. This equation is much more completely specified than the farm value equation for crops, because farm price indexes are available for each of the major categories. In addition, the farm-retail spreads are not so dominant.

The lag structure of the farm value in the farm-retail spread reflects the speed with which increases in farm value, which tend to reduce spreads, are recovered. The lags are shorter in this system than in the crop foods sector, due to the much more limited storability of the product group. Although the spread acts as a buffer for a portion of the increases in the farm value, it is short-lived and the old level of farm-retail spread is soon restored and even expanded. Wages in the food marketing industry lagged one quarter are of significant importance to the farm-retail spread in the current quarter. The omission of current wages is somewhat surprising but it is not inconsistent with the asserted behavior of packers to temporarily hold the line on small increases in the spread for competitive reasons. The time trend variable reflects the cost savings due to technology which have a depressing effect upon the retail spread.

Consumer price index for food at home. This equation is essentially an adding-up procedure, since by definition the total farm value plus the total farm-retail spread should equal the retail cost. However, the Bureau of Labor Statistics (BLS) consumer price index for food at home includes fish, coffee, and other miscellaneous foods as well as the foods in the USDA market basket. The relative weights of the farm value and spreads of each of the product groups in the retail cost of the market basket and in the BLS consumer price index for food at home, along with the corresponding regression coefficients, are shown in table 1. This table shows that the retail price equation is not an identity but it is closely related to the market basket system.

Consumer price index for all food. This equation is exogenous to the system but designed to be recursively determined by the system. Initial attempts to relate the index to food at home resulted in very low Durbin-Watson statistics, indicating potential first order positive autocorrelation. Utilizing the Cochrane-Orcutt iterative technique for first order schemes, the *TCPIF** equation was obtained.[10] The acceptance of this equation was not wholly based upon the very acceptable R^2 and t values which were obtained in the adjusted equation. The validity of the equation was reinforced by comparison of the coefficient of the consumer price index for food at home in the equation with its actual relative importance in the all-food price index. The actual weight in 1967 was 0.788 while the regression coefficient is 0.780. The balance of the index (0.220) relates to food eaten away from home. The time trend remains significant in explaining the continued uptrend in food costs.

[10] D. Cochrane and G. H. Orcutt. Application of Least-Squares Regressions to Relationships Containing Auto-Correlated Error Terms. Jour. Amer. Statis. Assoc., Vol. 44, pp. 32-61, 1949.

Table 1.—Food price composition: Relative weights for farm value and farm-retail spread by major product group, 1967

Item	Weights in retail cost, market basket	Weights in BLS food-at-home index	Regression coefficients food-at-home equation
Livestock food products:			
Farm value	0.29207		0.2253
Farm-retail spread	0.26103		0.3656
Total	0.55310	0.515	0.5909
Crop foods:			
Farm value	0.08886		0.1535
Farm-retail spread	0.31183		0.2758
Total	0.40069	0.413	0.4293
Total livestock and crops	[1] 0.95379	[2] 0.928	1.0202

[1] The balance of the retail cost is due to miscellaneous products.

[2] The balance of the CPI is composed of sweeteners, beverages, and miscellaneous products.

Appraisal of the Model Over the Historical Period, 1960-71

The appraisal of the model for 1960-71 was based on estimates generated by using a Gauss-Seidel numerical technique.[11] This technique yields results equivalent to the reduced form estimates when dealing with a linear system. However, the major advantage is its greater flexibility in providing solutions for a nonlinear system of reduced form equations when it is difficult to derive the reduced form coefficients from the structural coefficients. In addition, it is readily adaptable to changes in the equations within the system. Actual values for all variables were provided to the equation system for the fourth quarter of 1959, and earlier if required for the lag structure. Actual values for 1960-71 were provided only for exogenous and lagged exogenous variables. The system generated the values of the endogenous variables for 1960-71. The statistics and graphs presented are the results generated for the historical period covering 47 quarters.

Variances. In table 2, two sets of variances and standard deviations for each of the dependent variables indicate the amount of variability in the estimates. The first set of variances measures the variability of the point estimate from the actual indexes and reflects how well the model forecasts actual values for each variable. The second set of variances reflects how well the model forecasts the percentage changes from one quarter to the next. Although these variances are not completely independent, they do reflect the accuracy of the forecasts using different objectives.

In general, the variances are relatively small; those for farm value of crop foods and farm-retail spread for livestock products were the largest. The latter variables were two of the most volatile series and acceptable structural equations for them were difficult to estimate. The variances on the final two key equations are very small.

Graphs. Visual evidence of the goodness of fit over the historical period is contained in the graphs illustrating actual values and estimates generated by the model (figs. 2-7). As the previous statistics indicated, all the fits are good. The widest variations occur in the equations having the dependent variables with the largest variances and standard deviations.

Appraisal of the Model as an Aid in Forecasting

This model is not designed to be an entity unto itself whose forecasts are sacred. It is a supportive tool which should be used with other information, with the realization that the forecasts generated by the model are only as good as the forecasts of the exogenous variables that are provided. Prediction interval tests—tests of the predictive accuracy of the model for a period outside that on which the model is based—illustrate this point.

One of the objectives of this study was to provide a model which could be utilized both conveniently and rapidly with the least confusion. Toward this end, the above set of equations has been transformed into the reduced form equivalent. With the variables defined as in the "structural" system, the reduced form system and the autoregressive equation are presented below.

$$
\begin{aligned}
FVC_t = {} & 74.48797 + 0.09035\,PRO_t + 0.10825\,PRF_t \\
& + 0.25268\,PRV_t + 0.56814\,DSQ_t \\
& + 0.99486\,DTQ_t - 6.91831\,DWS_t \\
& - 4.65141\,DWA_t + 0.24244\,WFMI_t \\
& + 0.03125\,FVC_{t-1} - 0.05005\,FVC_{t-2} \\
& - 0.00453\,FVC_{t-3} - 0.02493\,FRSC_{t-1} \\
& - 0.33703\,FRSC_{t-2}
\end{aligned}
$$

[11] For a discussion of the Gauss-Seidel method for linear systems, see: V. N. Faddeeva. Computational Methods of Linear Algebra. Dover, pp. 131-143, 1959. Translated by C. D. Benstev.

Table 2.—Variances of the fitted model

Variable	Variances		Standard deviations	
	Point estimates (indexes)	Percentage change estimates	Point estimates (indexes)	Percentage change estimates
Farm value:				
Livestock food products	1.192	1.598	1.092	1.264
Crop foods	3.502	4.139	1.871	2.034
Farm-retail spreads:				
Livestock food products	2.619	6.376	1.618	2.525
Crop foods	0.722	1.106	0.850	1.052
CPI for food at home	0.389	0.508	0.623	0.713
CPI for all food	0.548	0.308	0.740	0.555

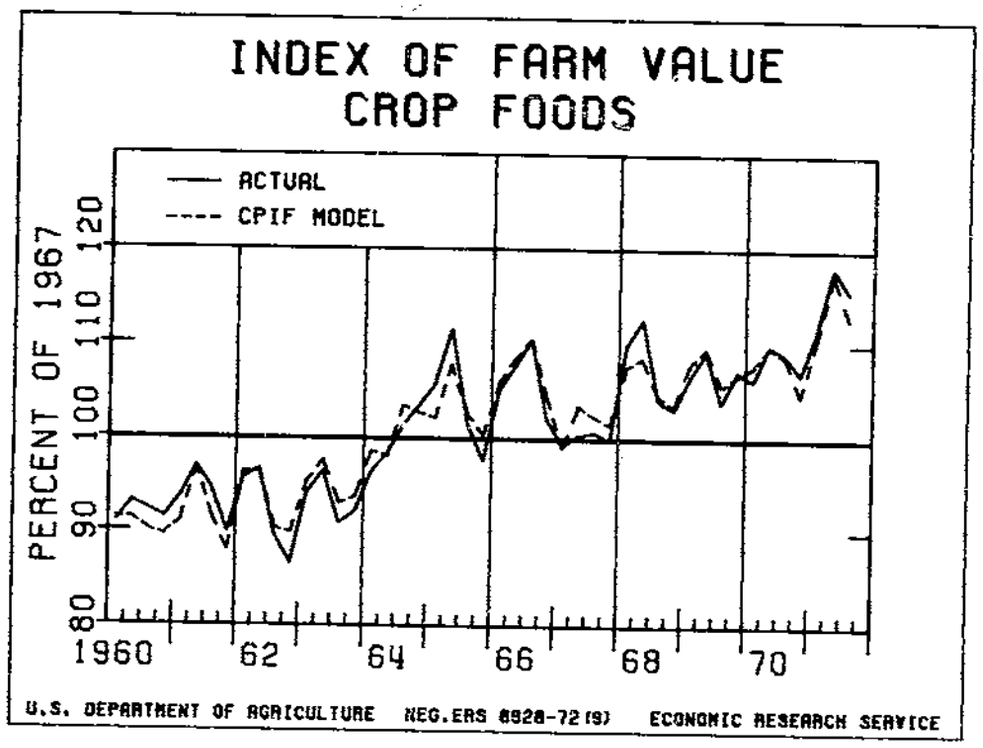


Figure 2

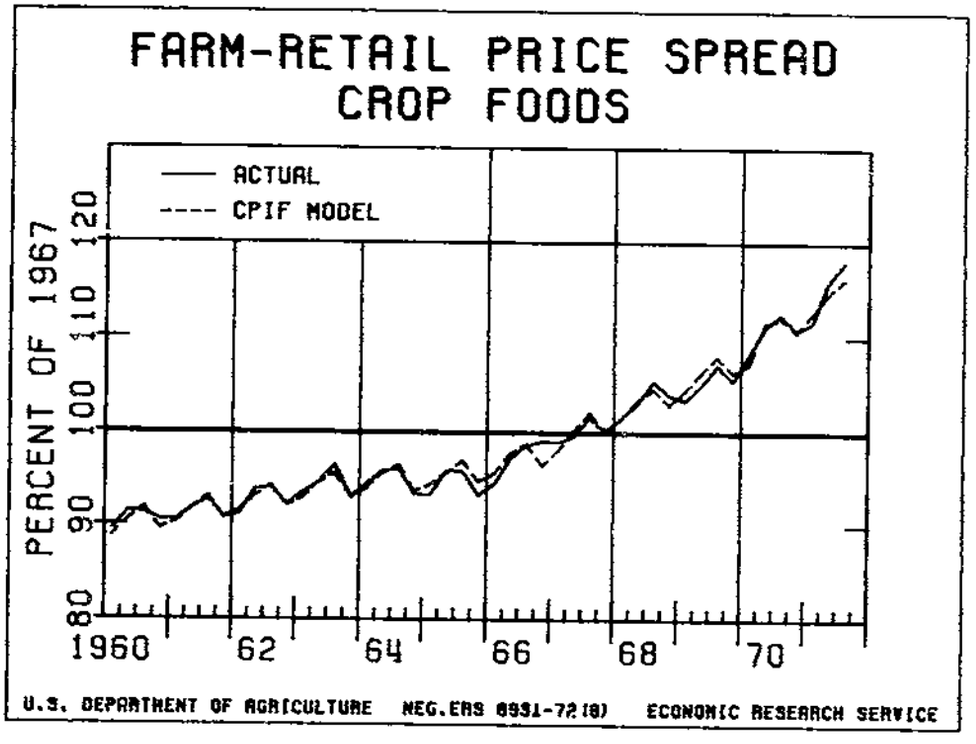


Figure 3

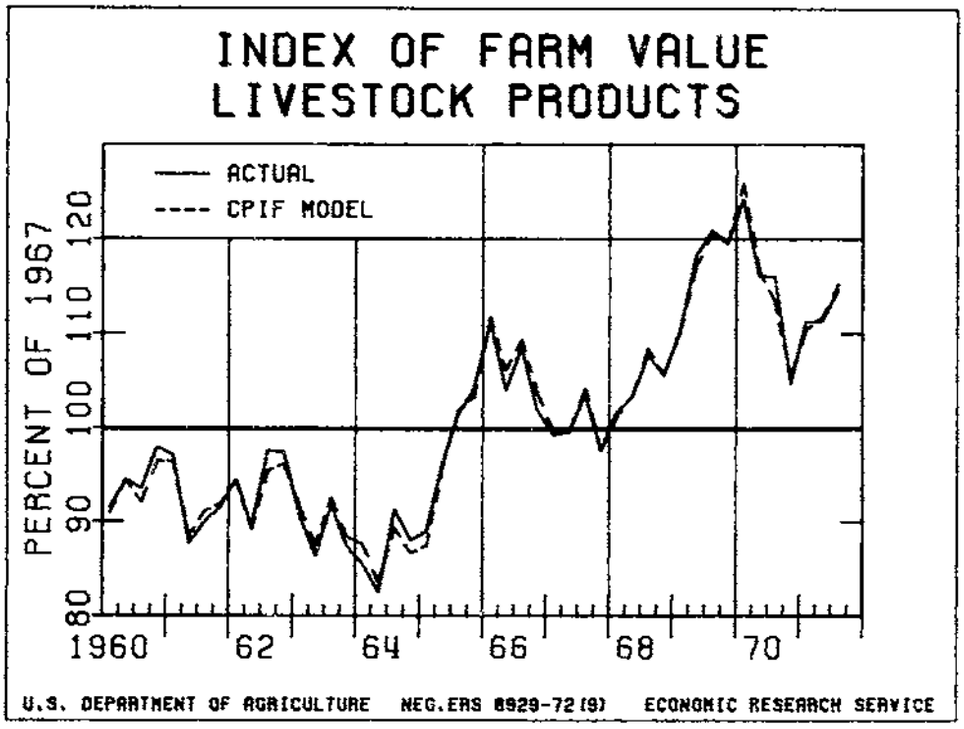


Figure 4

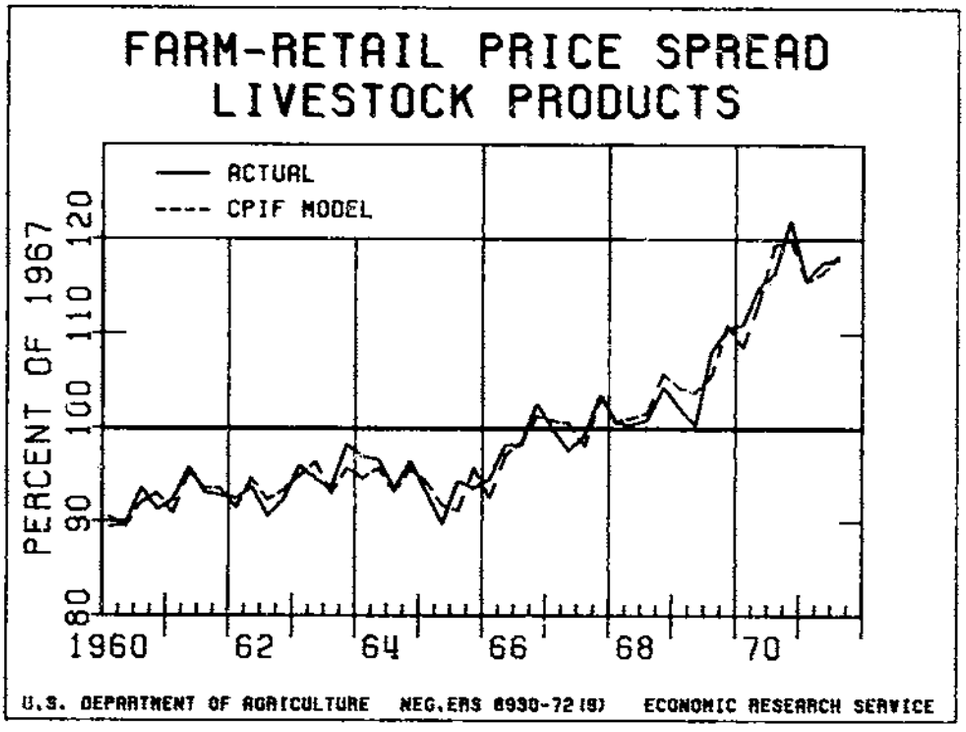


Figure 5

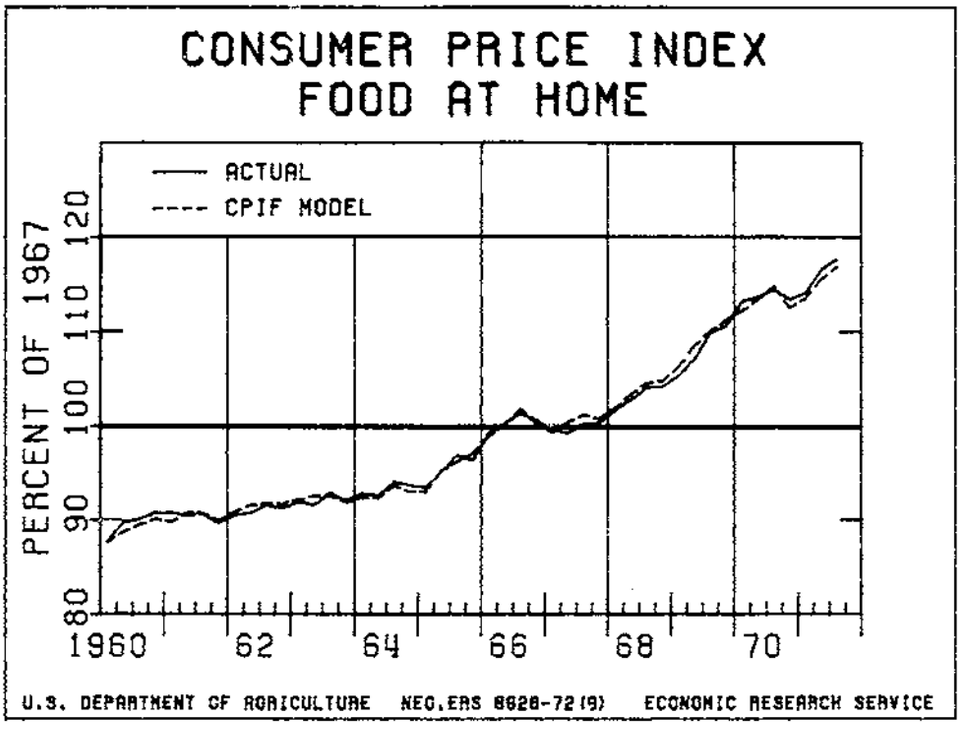


Figure 6

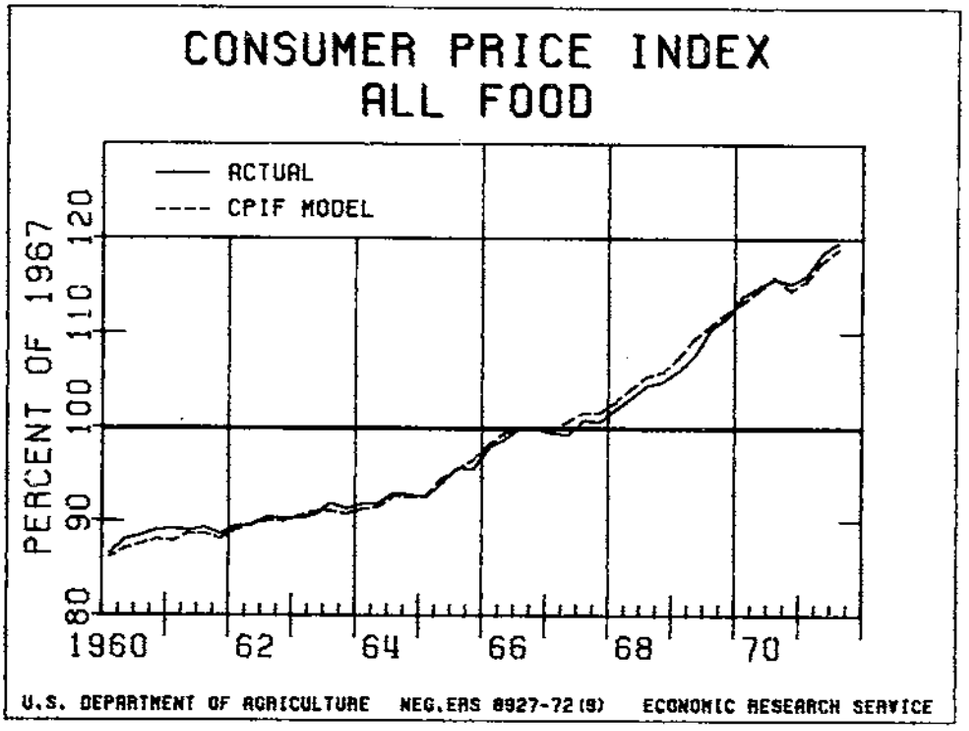


Figure 7

$$FRSC_t = 53.16963 - 0.01303\,PRO_t - 0.01561\,PRF_t - 0.03644\,PRV_t + 1.22337\,DSQ_t + 2.14224\,DTQ_t + 0.99762\,DWS_t + 0.67073\,DWA_t + 0.52204\,WFMI_t + 0.06729\,FVC_{t-1} - 0.10778\,FVC_{t-2} - 0.00975\,FVC_{t-3} + 0.00359\,FRSC_{t-1} + 0.04860\,FRSC_{t-2}$$

$$FVL_t = 21.35997 + 0.73436\,PRM_t + 0.28173\,PRD_t + 0.18350\,PRP_t + 0.00288\,PRO_t + 0.00345\,PRF_t + 0.00806\,PRV_t - 1.08850\,DFQ_t + 0.11907\,DSQ_t + 0.20850\,DTQ_t - 0.22063\,DWS_t - 0.14834\,DWA_t + 0.05081\,WFMI_t - 0.74162\,D4Q_t + 0.19058\,T_t - 0.08810\,FVL_{t-1} - 0.07632\,FVL_{t-2} + 0.00655\,FVC_{t-1} - 0.01049\,FVC_{t-2} - 0.00095\,FVC_{t-2} - 0.00080\,FRSC_{t-1} - 0.01075\,FRSC_{t-2} - 0.34756\,WFMI_{t-1}$$

$$FRSL_t = 6.64355 - 0.27061\,PRM_t - 0.10382\,PRD_t - 0.06762\,PRP_t - 0.00106\,PRO_t - 0.00127\,PRF_t - 0.00297\,PRV_t + 0.40111\,DFQ_t - 0.04388\,DSQ_t - 0.07683\,DTQ_t + 0.08130\,DWS_t + 0.05466\,DWA_t - 0.01872\,WFMI_t + 2.25749\,D4Q_t - 0.53923\,T_t + 0.26816\,FVL_{t-1} + 0.23232\,FVL_{t-2} - 0.00241\,FVC_{t-1} + 0.00387\,FVC_{t-2} + 0.00035\,FVC_{t-3} + 0.00029\,FRSC_{t-1} + 0.00396\,FRSC_{t-2} + 1.05798\,WFMI_{t-1}$$

$$CPIF_t = 29.25527 + 0.06652\,PRM_t + 0.02552\,PRD_t + 0.01662\,PRP_t + 0.01054\,PRO_t + 0.01262\,PRF_t + 0.02947\,PRV_t - 0.09859\,DFQ_t + 0.43540\,DSQ_t + 0.76243\,DTQ_t - 0.80680\,DWS_t - 0.54244\,DWA_t + 0.18579\,WFMI_t + 0.65825\,D4Q_t - 0.09970\,T_t + 0.07819\,FVL_{t-1} + 0.06774\,FVL_{t-2} + 0.02395\,FVC_{t-1} + 0.03836\,FVC_{t-2} - 0.00347\,FVC_{t-3} - 0.00291\,FRSC_{t-1} - 0.03930\,FRSC_{t-2} + 0.30849\,WFMI_{t-1}$$

$$TCPIF_t^* = 0.2913 + 0.7804\,CPIF_t^* + 0.4047\,T_t^*$$

This system, when provided with forecasts of the respective indexes of prices received by farmers and the wage rate in the food marketing industry, will yield forecasts of the endogenous variables through direct substitution. The input forecasts are typically provided by the commodity specialists. The system is currently utilized on the remote access terminal (RAX) and has a running time of 10 minutes to provide forecasts covering four quarters. The results are equivalent to the Gauss-Seidel solution since the system is composed of linear equations. The interchange of techniques—reduced form and Gauss-Seidel—should not be interpreted as anything but a preference for convenience on the part of the authors and users of the program.

Prediction-interval tests. The prediction-interval test, based on the third quarter of 1971 as a starting point, is conducted for the fourth quarter of 1971 and the first and second quarters of 1972 using a full model solution, and using the estimated lagged endogenous variables in one period as input into the model for later periods. Actual and predicted point estimates and percentage changes were compared (table 3). The variances of the CPI for food at home and all food indicate relatively good prediction-interval results in spite of near-record increases in meat prices and wages in food marketing

Table 3.—Prediction-interval test

Item	1971 IV		1972 I		1972 II		Standard deviation
	Actual	Prediction	Actual	Prediction	Actual	Prediction	
Point predictions:							
Farm value:			*Index (1967 = 100)*				
FVL	115.1	116.6	124.0	126.0	124.4	124.6	1.448
FVC	116.5	113.8	113.7	112.2	115.0	116.7	2.035
Farm-retail spread:							
FRSL	117.5	121.1	118.6	117.5	118.1	124.8	4.437
FRSC	115.3	113.8	117.1	117.0	117.2	118.2	1.042
CPI for food at home	117.2	116.8	119.8	118.2	120.5	121.6	1.144
CPI for all food	119.4	119.2	121.6	120.7	122.6	123.7	0.829
Percentage change predictions:							
Farm value:			*Percent*				
FVL	0.392	1.653	7.658	8.031	0.323	−1.075	1.108
FVC	0.971	−1.429	−2.428	−1.397	1.143	3.983	2.062
Farm-retail spread:							
FRSL	0.339	2.684	0.936	−3.020	−0.522	6.321	4.760
FRSC	−2.270	−3.620	1.508	2.827	0.085	1.031	1.219
CPI for food at home	0.424	−3.620	2.303	1.232	0.584	2.875	1.356
CPI for all food	−0.167	−0.334	1.842	1.258	0.822	2.486	0.905

Table 4.—Short-run impacts of quarterly changes

Exogenous variable	Magnitude of change	Short-run impacts on endogenous variables expressed as changes in index (1967 = 100)					
		FVL	*FVC*	*FRSL*	*FRSC*	*CPIF* at home	*CPIF* all food
Index of prices received for meat animals	1 index point or $0.386/cwt. or $0.646/cwt.	0.7344	0	−0.2706	0	0.0665	0.0519
Cattle							
Hogs							
Index of prices received for dairy products	1 index point or $0.054/cwt.	0.2817	0	−0.1038	0	0.0255	0.0199
Milk (wholesale)							
Index of prices received for poultry and eggs	1 index point or $0.005/doz. or $0.006/pound	0.1835	0	−0.0676	0	0.0166	0.0129
Eggs							
Broilers							
Index of prices received for fruit	1 index point or $0.002/pound	0.0034	0.1082	−0.0013	−0.0156	0.0126	0.0098
Apples							
Index of prices received for vegetables	1 index point or $0.152/ton	0.0081	0.2527	−0.0030	−0.0364	0.0295	0.0230
Tomatoes							
Index of wages in food marketing industries	1 index point or $0.025/hour	0.0508	0.2424	−0.0187	0.5220	0.1858	0.1450
Change in hourly wage							

industries compared with the historical period of the model. The somewhat atypical wage increases are attributable to deferred pay raises. The remainder of the variances are in line with the pattern shown by the tests of the fitted model over the historical period.

Although 1971-72 is not a very satisfactory period for testing the model because of market distortions caused by the wage-price control program imposed on August 15, 1971, the higher estimates in the spread and food price equations generated by the model tend to be consistent with the consensus that prices were held down to some extent by controls.

Impact multipliers. The one-quarter, or short-run, impacts of the changes in the exogenous variables on the endogenous variables are shown in table 4. All changes are related to a unit change in the exogenous variables which are in the form of indexes. Examples of individual price changes necessary to achieve these unit changes in the indexes are provided and are based on SRS weights used in combining the prices to obtain the indexes. The most significant variables with regard to the consumer price index for food are prices received by farmers for meat animals and wages in the food marketing industry. For example, an increase of 39 cents per 100 pounds of beef cattle causes an increase of 0.0719 in the consumer price index for food at home. An increase of 65 cents per 100 pounds in hogs yields the same result. Wages in the food industry have an immediate impact of 0.2053 for every increase of 2½ cents per hour.

The long-run impacts in table 5 show the amount by which the endogenous variables will be raised for a unit change in the index after the change has worked completely through the system. For example, if the index of prices received for meat rose one unit and remained at the new level, there would be a short-run impact of 0.0719 on the CPI for food at home. In the next quarter, the lagged farm value for livestock will influence the spread and also the CPI for food at home and the farm value for livestock. This process continues until the levels of the endogenous variables are con-

Table 5.—Long-run impacts

Exogenous variable	Magnitude of change	Long-run impacts on endogenous variables expressed as changes in index (1967 = 100)					
		FVL	*FVC*	*FRSL*	*FRSC*	*CPIF* at home	*CPIF* at home and away
Index of prices received for meat animals	1 index point or $0.386/cwt. or $0.646/cwt.	0.6317	0	0.0419	0	0.1576	0.1230
Cattle							
Hogs							
Index of prices received for dairy products	1 index point or $0.054/cwt.	.2423	0	0.0160	0	0.0605	0.0472
Milk (wholesale)							
Index of prices received for poultry and eggs	1 index point or $0.005/doz. or $0.006/pound	0.1578	0	0.0105	0	0.0394	0.0307
Eggs							
Broilers							
Index of prices received for fruit	1 index point or $0.002/pound	0.0027	0.1130	0.0001	-0.0225	0.0118	0.0092
Apples							
Index of prices received for vegetables	1 index point or $0.152/ton	0.0063	0.2638	0.0003	-0.0525	0.0275	0.0215
Tomatoes							
Index of wages in food marketing industries	1 index point or $0.025/hour	-0.2593	0.0452	0.9073	0.5450	0.4305	0.3359
Change in hourly wage							

sistent with the new farm price level. The long-run effect is the difference between the level before the increase and that after the increase. Although the endogenous variable for the farm-retail spread for livestock food declines in the first round, after four quarters it increases to a spread level consistent with the new farm price. In general, the long-run impacts are fully worked out in a comparatively short time, with the longest time lapse covering about four quarters.

Conclusions and Forecasts for Last Two Quarters of 1972

The model for forecasting consumer price indexes for food was constructed to utilize information on farm level prices and food marketing wages to forecast the price level for food. To achieve this objective, the equation system utilized both recursive and simultaneous relationships to analytically describe the differences in the markets for crop foods and livestock food products. Since this system contains exogenous coefficients with opposite signs in the farm value and farm-retail spread equations, it has some built-in stabilizers. If the farm value forecast is too high, there is increased downward pressure on the farm-retail spread forecasts, and vice versa. This system results in a model which forecasts the consumer price index for food at home and for all food with an acceptable degree of accuracy.

Forecasts for the last two quarters of 1972, based on forecasts of the exogenous variables as of July 1972, are shown in table 6. Utilizing the actual values for the CPI for food categories for 1972 I and II, the model forecast an annual increase for 1972 of 4.8 percent in the consumer price index for food at home and 4.6 percent in the consumer price index for all food. The official forecasts relied heavily on this type of information but were tempered to some extent by judgment of commodity specialists and others in the Department of Agriculture.

Table 6.—Forecasts of indexes for 1972
(1967 = 100)

Item	Third quarter	Fourth quarter
Farm value:		
FVL	132.7	125.9
FVC	116.4	111.7
Farm-retail spread:		
FRSL	123.3	130.8
FRSC	120.3	126.2
CPI for food at home	123.5	124.2
CPI for all food	125.3	126.2