ESTIMATING NATIONAL STOCKS OF GRAIN

FROM AVAILABLE WEEKLY INFORMATION

Fred J. Ruppel
Assistant Professor

and

Stan Bevers
Research Assistant

Department of Agricultural Economics

Texas A&M University

Texas Agricultural Experiment Station

February 1988

The authors wish to thank Tom Sporleder and Wes Peterson for helpful comments.

AAEA 1988

ABSTRACT

A method for estimating national quarterly stocks of corn, sorghum, soybeans and wheat from available weekly quantity data is introduced and applied to 1975-1987 data. Preliminary results are presented. Refinement of this technique will allow for estimation of national stocks of grain at any point in the marketing year.

Introduction

Commodity prices are extremely dependent on available market information. Prices rely heavily on regularly published private and public reports, and often respond in dramatic fashion to unanticipated market information. Market analysts often point to the surprise Russian grain purchases of 1972 as one of the more prominent incidents of incorrect anticipation of commodity price movements by market participants. On July 10 of that year the USDA reported that large amounts of wheat and corn had been sold to the Soviet Union, presumably at then-existing market prices. As available supplies began to dwindle and further information on additional purchases began to filter to market participants, the average farm price of wheat rose from $1.32 per bushel in July to $2.38 in December, an 80 percent increase in less than six months.[1]

While unpredictable events can have dramatic price consequences, routine events can also have price impacts. The federal government's release of regularly scheduled commodity supply and demand information generally triggers some movement in market prices, though that movement is typically small. Crop production estimates fall into this category. The USDA follows a given commodity from pre-planting until after the harvest, regularly reporting on planting intentions, actual planted acres, projected crop estimates, modifications of crop estimates, and finally, the estimated harvest. At each reporting point the new information may have large price impacts, especially when the disparity between the newly released information and prior expectations surrounding that information is large.

Quarterly USDA estimates of national stocks of grain fall into the category of regularly scheduled information which sometimes triggers substantial price movements. USDA estimates for the major grains are released near the end of the month in March, June, September, and December and reflect on- and off-farm stocks as of the first of the month. Domestic disappearance for the most

recent quarter can be estimated by combining newly-released stocks information with data on export activity and stocks information from the previous quarter's report. Grain market participants rely heavily on this stocks information.

There are at least two problems with the USDA quarterly stocks information. The first lies in its lack of frequency. Much can happen in grain markets in three months. Prior to mid-1986 (when the reports dates were last changed), there were waiting periods of four months for the major grains between June and October and for soybeans between September and January. A second problem is also one of time. The information is already three to four weeks old by its release date. Due to the immense data task required, that length of time is not easily shortened.

The present study is concerned with the timeliness of grain stocks information. The objective of the study is to introduce a method for estimating national quarterly stocks of corn, sorghum, soybeans and wheat using available weekly quantity data. That method will be applied to selected 1975-1987 data generated from weekly reports released on or shortly after the USDA quarterly stocks report dates. Preliminary results will be presented. It will be shown that further refinement of this estimation technique will allow for estimation of national stocks of grain at any point in the marketing year.

Weekly Data Availability and Potential Usefulness

The USDA publishes a number of weekly bulletins reporting data on grain stocks and movements. Grain Market News, published by the Agricultural Marketing Service, is the best known and most widely referenced of these publications, but it is not likely to be of much help in estimating national stocks of grain. Grain Market News includes information on quantities of grain inspected for export shipment as well as summary information on weekly cash and futures prices. The reported prices are certainly responding to national and international market information, but price movement alone does not provide

information on the cause of the movement. Likewise, grain inspected for export is already shipped and no longer a part of U.S. stockholdings.

Two other USDA weekly publications seem more promising for predicting national stocks of grain. Stocks of Grain at Selected Terminal and Elevator Sites, published by the Livestock and Grain Market News Branch, Livestock Division, lists quantities of grain in "deliverable locations" at 53 reporting points throughout the United States. This information is apparently widely used by market participants, so much so that the Chicago Board of Trade reports newly-released information on its electronic network and publishes the summary data in its Statistical Annual.[2] More than 300 sites voluntarily report their on-site stock levels for wheat, corn, soybeans, sorghum, oats, barley, rye and sunflower seeds. These reporting sites include the largest grain handling facilities across the United States, representing the major production centers, inland terminals, and export and processing facilities. The amount of grain held in these facilites as a percentage of total estimated national stocks of grain varies by commodity and tends to be cyclical within marketing years, peaking with the harvest. Reported stocks of corn and soybeans typically range from two to ten percent of total national stocks, while wheat ranges between 13 and 26 percent. Reported stocks of sorghum as a percentage of national stocks are more variable, ranging between 10 percent and 50 percent, but typically representing 20 percent of national stocks.

The Foreign Agricultural Service publishes U.S. Export Sales, which reports information on weekly export sales and shipments and outstanding export sales by marketing year of intended delivery for over twenty agricultural commodities.[3] The report includes destination-specific information on accumulated exports and outstanding export sales for selected commodities. Information on large sales (100,000 or more metric tons) is reported under a daily reporting system. The reports are mandatory for all exporters of

designated U.S. commodities, and were initially generated as a result of the unexpected Russian grain purchases of 1972 and the resulting price increases in agricultural commodities and value-added agricultural products.

Estimating the Demand for Ending Stocks of Grain

Traditionally the demand for ending grain stocks is specified as a structural equation in a single-equation model or as one equation in an econometric system. Clearly the most important variable in explaining ending stocks is the level of beginning supply. In fact, since stock depletion follows a consistent seasonal cycle, including only the level of beginning supply and a seasonal variable in an ad hoc structural equation explained over 95 percent of the variation in ending stock levels for the four commodities in this study. However, aberrations around the normal cycle cannot be predicted by using only these explanatory variables. Other variables which are typically included in estimates of stock demand include commodity (cash and/or futures) prices and the interest rate. Both of these variables reflect the opportunity cost of carrying stocks into the next period, since income could have been generated from the sale of the stocks and interest could have been earned on the additional income. Estimates following this structural form were reported for quarterly corn, soybeans and wheat ending stocks by XXXXXX and by Chambers and Just. XXXXXX's estimates showed an R^2 of 0.99 for all three commodities, with very strong coefficients relative to their standard errors on the lagged dependent variables. Chambers and Just split beginning supply into production and lagged ending stocks, but also reported high explanatory power and strong coefficients relative to standard errors on the quantity variables.

What is desirable in predicting ending stock demand is to account for aberrations around the normal cycle, that is, to estimate the difference between beginning supply and ending stocks. The change in stocks is often

referred to as "total disappearance", since the change in stock levels is identically equal to the sum of domestic disappearance and export shipments. The two terms (change in stocks and total disappearance) are used interchangeably in this paper. Once an estimate of total disappearance is obtained, this (positive) change in the stock level can be subtracted from the level of beginning supply to generate an estimate of ending stocks. An even more enticing prospect is the possibility of estimating the change in stocks at any point in the marketing quarter, thereby generating more complete information on grain stocks and flows for market participants than is currently available. The use of published weekly quantity data allows for this estimation.

Quantities of stocks in deliverable positions and levels of outstanding export sales both show promise as explanatory variables in total disappearance estimation. Stock levels at various locations increase and decrease as the marketing year progresses. For major inland terminals nearer the production centers, we would expect a cyclical pattern of high stocks at the harvest decreasing somewhat through the marketing year. Major export locations and river terminals on the other hand would be more related to the shipment season, varying cyclically with both the harvest and weather patterns. Minor terminals and export points would be expected to reflect overall levels of storage and shipment activity, increasing in reported stocks levels with high national stocks levels and high export demand. Stocks in deliverable positions also provide some measure of both on-farm and off-farm stock levels since on-farm levels not only decrease through on-farm use during the course of the marketing year, but also tend to keep stock levels higher at the grain stocks reporting points near the production centers as producers deliver their stored crop after collecting some storage premium.

Outstanding export sales provides a particularly good measure of current export activity since past shipments are excluded from the count and only those

contracted sales awaiting export are included. As mentioned earlier, the outstanding sales data are reported by marketing year of intended delivery. As the marketing year progresses, outstanding sales intended for current marketing year delivery decrease while those targeted for next year delivery increase. Outstanding sales also provide a further link between off- and on-farm stocks, since higher than normal levels of outstanding sales would point to increases in future grain movement off the farms and into the marketing channels.

Estimating total grain disappearance from available weekly data is not a straightforward procedure. A solution to the problem lies in the recognition that a given quantity of stocks or outstanding sales at one point in the marketing year carries different meaning (or market information) than the same level at a different point in the marketing year. Both the quantity reported and the timing of the report are important bits of information. When an explanatory variable is believed to have different impacts on the dependent variable for differing levels of another explanatory variable, economic theory suggests the use of "interaction terms" (or "interaction variables") in the estimation process. Interaction terms are generated by multiplying the two explanatory variables together, thereby creating a third variable, and inserting all three variables into the estimating equation. The derivative of the dependent variable with respect to either of the original explanatory variables is then calculated as its own coefficient plus the product of the coefficient on the interaction term and the value of the other variable.[4]

Results

Reported levels of deliverable stocks and of outstanding export sales carry different market information depending on the time of the year. These variables have been multiplied by a seasonal variable which reflects the number of weeks since the beginning of the marketing year (SEAS). Deliverable stocks have been disaggregated into eight reporting regions: Atlantic Coast (ATLC),

Great Lakes (GRLK), River Points (RVPT), Gulf Ports (GULF), Plains Area (PLNS), Southwest (STHW), Pacific Northwest (PCNW) and California Ports (CALP). Outstanding export sales are reported for intended delivery in the current marketing year (OSC) and in the next marketing year (OSN). These ten original variables, the ten interaction terms (the above variables preceded by an "S"), and the time variable have been included as explanatory variables in a structural equation which estimates quarterly total disappearance for four commodities, corn, sorghum, soybeans and wheat, between 1975 and 1985.

The results of this estimation are presented in Table 1. The equations are presented vertically, with coefficients on the right-hand-side variables and absolute values of the associated t-statistics (in parentheses) as the rows of the table. The interaction terms are paired with the original variables to enhance readability. Summary statistics are provided as the last four rows of each column. For each commodity, the explanatory power as measured by R^2 is greater than 80 percent, with the adjusted R^2 on average ten percentage points lower. The null hypothesis of zero first order serial correlation in the residuals as measured by the Durbin-Watson statistic could not be rejected in any of the equations.

The relatively large amount of explained variation occurs in spite of a large number of coefficients not significantly different from zero. Typically this result points to multicollinearity within the estimating equation. With multicollinearity the estimated coefficients are unbiased, though the standard errors on those coefficients are inflated. Hence, equations reflecting a high degree of multicollinearity may still be used for forecasting. Point estimates will be unbiased, but the resulting standard errors of those estimates could be large, resulting in narrow confidence intervals.

In order to generate predictions of ending stock levels, estimates of quarterly stock changes from the coefficients in Table 1 were subtracted from

Reporting regions and sites

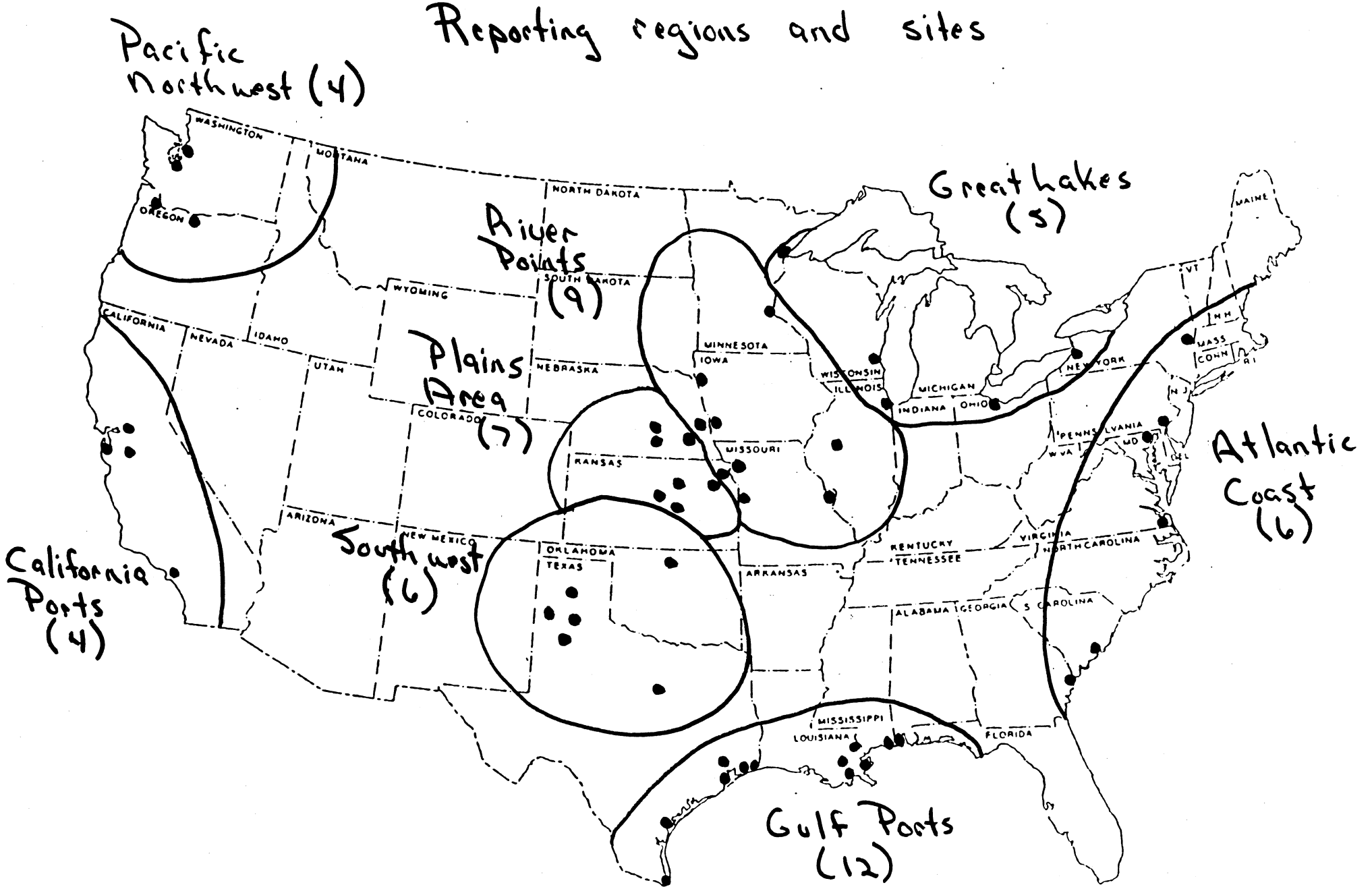


Table 1. Estimates of Changes in Grain Stock Levels

(Quarterly, 1975-1985)

Independent Variables	Dependent Variables: Corn	Sorghum	Soybeans	Wheat
OSC	1.70 (1.85)	-0.33 (0.18)	0.18 (0.23)	1.80 (1.63)
SOSC	-0.01 (0.54)	0.01 (0.12)	-0.00 (0.03)	-0.03 (1.06)
OSN	-12.73 (3.25)	-0.65 (0.32)	-1.66 (2.55)	-3.78 (1.00)
SOSN	0.27 (3.40)	0.02 (0.51)	0.01 (0.65)	-0.09 (1.07)
ATLC	17.79 (0.25)	-- --	84.25 (2.52)	-34.78 (1.65)
SATLC	-0.27 (0.11)	-- --	-2.45 (2.56)	0.87 (1.44)
CALP	-66.24 (0.66)	-0.65 (0.01)	367.59 (1.51)	-92.78 (2.53)
SCALP	0.49 (0.10)	1.57 (0.53)	0.14 (0.02)	2.08 (1.52)
GRLK	33.20 (1.29)	-- --	3.30 (0.91)	2.36 (0.15)
SGRLK	-1.11 (1.24)	-- --	-0.03 (0.34)	-0.05 (0.10)
RVPT	-24.54 (1.62)	3.51 (0.35)	3.34 (0.31)	10.71 (1.35)
SRVPT	0.59 (1.28)	-0.04 (0.10)	0.02 (0.06)	-0.29 (1.35)
GULF	-53.23 (1.67)	-6.40 (0.70)	-21.29 (1.20)	-0.86 (0.07)
SGULF	2.17 (2.17)	0.32 (1.27)	0.71 (1.44)	0.08 (0.28)
PLNS	58.32 (1.44)	1.33 (0.30)	51.06 (1.19)	2.01 (0.57)
SPLNS	-1.46 (1.09)	-0.05 (0.42)	-3.10 (1.71)	-0.07 (0.67)
STHW	30.37 (0.57)	0.27 (0.09)	-72.27 (0.92)	0.36 (0.57)
SSTHW	-0.01 (0.01)	0.08 (0.67)	3.70 (1.42)	0.04 (0.20)
PCNW	93.03 (0.99)	10.23 (0.54)	-46.79 (0.34)	10.20 (0.67)
SPCNW	-1.97 (0.53)	-0.21 (0.33)	1.60 (0.38)	-0.45 (1.05)
SEAS	-26132 (0.99)	-6052 (1.53)	-4680 (1.67)	10749 (0.80)
INTE	1759300 (1.75)	297190 (2.27)	464250 (3.75)	36787 (0.07)
R^2	0.86	0.81	0.95	0.90
ADJ R^2	0.73	0.68	0.91	0.80
D.W.	2.33	2.04	2.28	2.36
D.F.	22	26	22	22

NOTE: Dependent variable is quarterly changes in grain stock levels (total disappearance. Absolute values of t-statistics are reported in parentheses. See preceding page for variable definitions.

beginning supply levels. These predictions were then compared with reported USDA ending stock levels. Figures 1 through 4 present plots of actual and predicted values of ending stock levels for the four commodities. The figures show in-sample predictions using data through calendar year 1985, with out-of-sample projections for 1986 and the first three (calendar) quarters of 1987. Rather than chart the data points directly, vertical lines have been drawn connecting the actual USDA quarterly figures (the o's) with the predicted values (the x's). Thus the vertical lines reflect the magnitude of the error in the prediction. Multiple points (where the plotter could not distinguish two values) are shown by a plus sign (+). Observations to the left of the solid vertical line are in-sample; those to the right are out-of-sample.

There are three observations which can be made about the plots. First, as expected, the in-sample predictions fared better than the out-of-sample projections. Over half of the in-sample predictions are multiple points, compared to three out-of-sample multiple points (all in wheat). However, ending stocks are generally larger in the later years, and multiple points often mask larger percentage errors (especially at lower stock levels). Still, the mean percentage errors are smaller in-sample than out-of sample (6, 11, 6, and 4 percent compared to 10, 19, 10, and 7 percent for corn, sorghum, soybeans and wheat, respectively). Second, negative predicted ending stock levels (early corn and sorghum) and negative stock changes within the marketing year (between the first and second out-of-sample wheat projections) are clearly inappropriate estimates. Third, there are three out-of-sample USDA figures missing on the sorghum plots, since ending stocks for sorghum and a few other "lesser crops" are now reported only in June and September (this change effective with the mid-1986 change in the USDA ending stocks reporting dates). A dashed vertical line is drawn through these three predicted points to highlight the inability to make a comparison with USDA figures. A resultant

Figure 1. Corn: Actual USDA figures and predicted estimates of quarterly ending stocks.

o = Actual USDA figures

x = Predicted estimates

+ = Multiple point

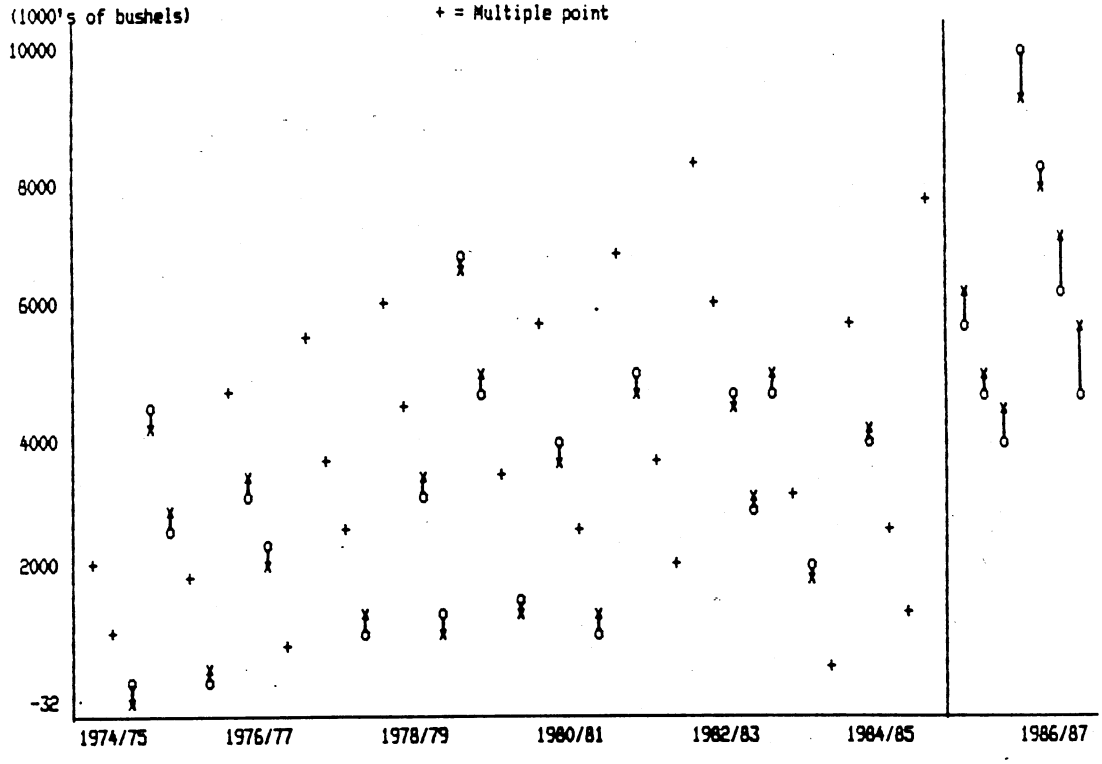


Figure 2. Sorghum: Actual USDA figures and predicted estimates of quarterly ending stocks.

o = Actual USDA figures

x = Predicted estimates

+ = Multiple point

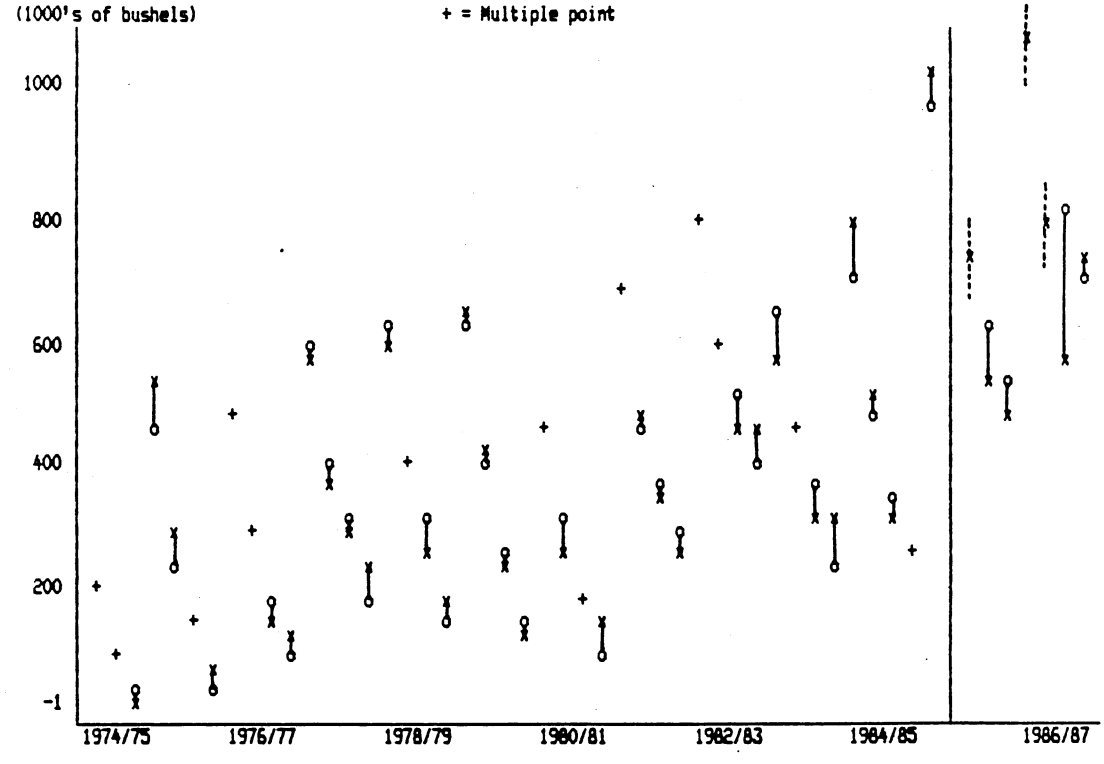


Figure 3. Soybeans: Actual USDA figures and predicted estimates of quarterly ending stocks.

o = Actual USDA figures
x = Predicted estimates
+ = Multiple point

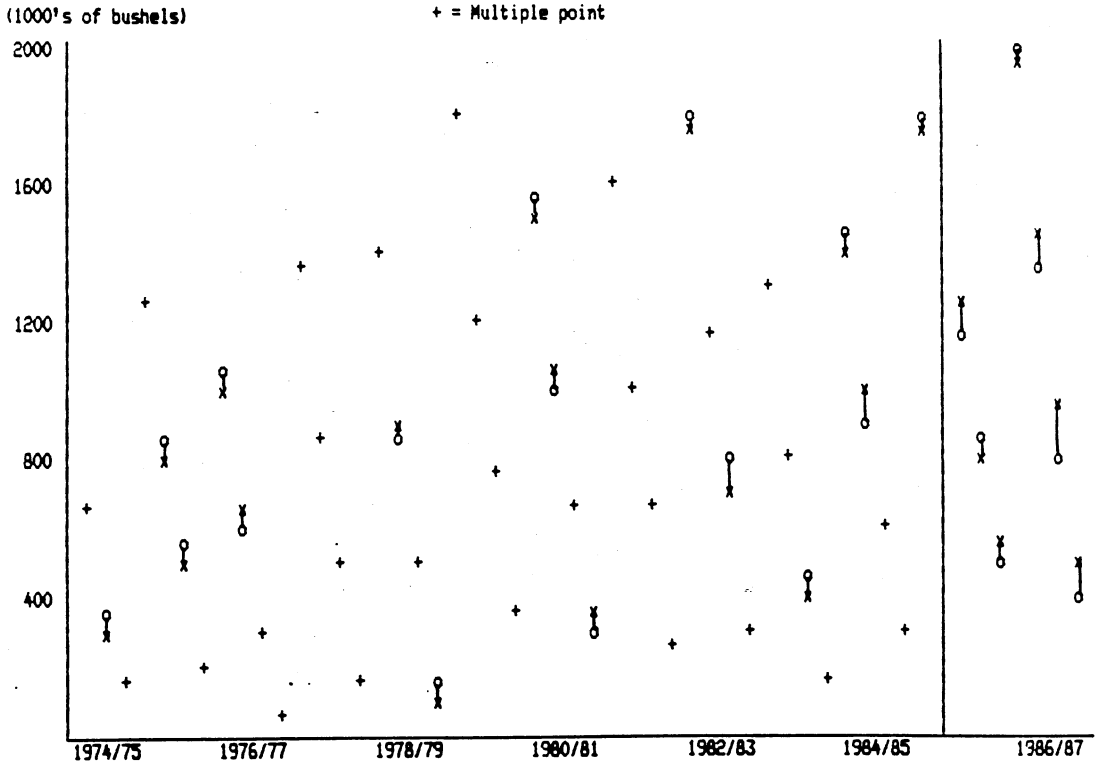
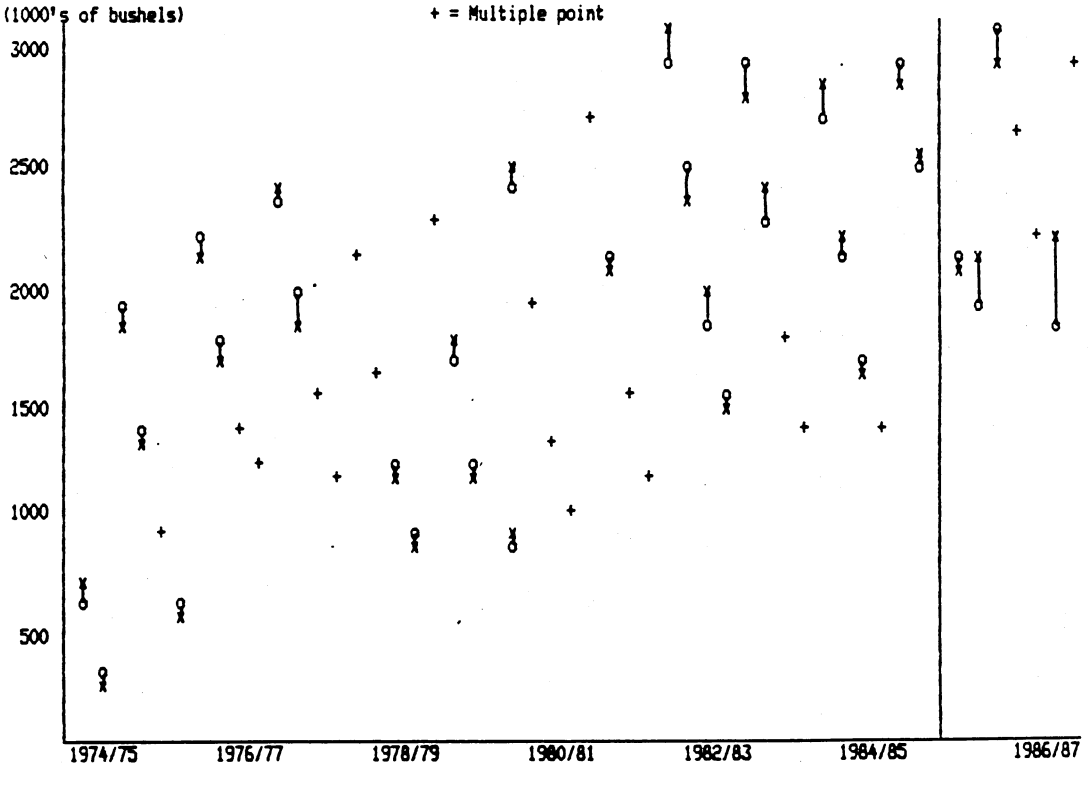


Figure 4. Wheat: Actual USDA figures and predicted estimates of quarterly ending stocks.

o = Actual USDA figures
x = Predicted estimates
+ = Multiple point



lack of beginning supply figures helps to explain the two largest out-of-sample prediction errors in sorghum.

The change in USDA ending stock report dates helps to explain larger than anticipated out-of-sample projection errors. Parameter estimates were based on the old two-, three-, and four-month quarters with projections made over the new standardized three-month quarters. This problem can likely be overcome as more observations with the new quarters are added to the estimation process. For instance, including the first six out-of-sample observations in the total disappearance estimations with only one out-of-sample projection generated projection errors of 1.3, 16.8, and 3.8 percent for corn, soybeans, and wheat, respectively, compared to 24.2, 23.6 and 5 percent in the earlier projections. Modification of the structural estimating equation is needed to account for the new report quarters.

Additional modification of this projection system would allow for point estimates of ending stock levels at any point in the marketing quarter. In order to accomplish this task, the number of weeks into the marketing quarter needs to be accounted for, in addition to the (current) number of weeks into the marketing year. Market participants could then receive estimates of current stock levels in early May or mid-July, for example, as well as projections of June 1 or September 1 quarter ending stock levels. Increased market information would help to stabilize price movements, since market participants would be less surprised by USDA figures.

FOOTNOTES

1. USDA, Wheat Situation, February 1973, p. 19.
2. Besant, Commodity Trading Manual, p. 42.
3. Outstanding export sales is a measure of sales which have been contracted but not yet delivered.
4. Pindyck and Rubinfeld, p. 110.

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