MARKET DEMAND FOR RESIDUAL STOCKS AND PRICE VARIABILITY:

A CASE STUDY OF U.S. WHEAT

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Instability of world grain prices in the 1970's has attracted renewed interest in examining the fundamental supply-demand relationships in this sector of the world economy.  In the last few years, numerous articles dealing with this issue have appeared in the professional journals (Grennes, Johnson, and Thursby; Johnson; Shei and Thompson; and Zwart and Meilke).  Few studies, however, have attempted to examine the changes in demand structure.  Furthermore, the market's desire to hold adequate residual grain stocks as precautional measures and its impact on prices has not been adequately addressed.

Fluctuations in grain prices in the 1970's were sparked by the sudden participation of the Soviet Union in world grain trade in 1972.  With additional pressures, due to crop failures and rising income in many grain importing countries, export demand for U.S. wheat nearly doubled, increasing from 610 million bushels in 1971 to 1,135 million bushels in 1972. Export demand has since remained strong and averaged 1.1 billion bushels per year.

Residual stocks in the U.S., as measured by the ending stocks (or initial stocks in the following years), reached a new low of 344 million bushels in 1973 or 17 percent of the total domestic and export demand. This marked the beginning of a new era and posed a challenge as to the ability of U.S. wheat industry to meet the growing export demand and thus to stabilize the market prices.  Undoubtedly, U.S. production capacity has proven more than adequate to meet the challenge (Yeh).  Acreage planted for

wheat has increased nearly 20 million acres from the 1960's to around 75 million acres in the late 1970's. Production overall has risen about 600 million bushels over the same period. However, weather induced fluctuations in production and uncertain export expectations have continued to impact residual stock levels and, thus, market prices. The recent suspension of grain sales to the Soviet Union could further complicate such uncertainty.

Domestic wheat consumption has been relatively stable over the past 20 years. Fluctuations in the levels of residual stocks were mainly due to the fluctuations in supply and in export demand. Therefore, treatment of residual stocks as a part of market demand appears to be particularly important, especially based on the experience of the 1970's. The purpose of this analysis, thus, is twofold: (1) to examine the changes in wheat demand submarket structure, before and after 1972; and (2) to test the sensitivity of the level of residual stocks and the changes in export demand relative to the expected total supply on market price determination.

## MODELS

This study divides the years under study into two distinct periods. The first period covers 1961-71; the second 1972-78. It is assumed that the second period distinguishes itself from the first period with high export demand, highly fluctuating supplies and residual stocks, and uncertain market prices.

Market demand for U.S. wheat is divided into three distinct submarkets: domestic demand, export demand, and the market's desire to hold residual stocks as precautionary demand. A fourth submarket combines domestic and export demand.

A simple demand function is defined and the generalized price flexibility function for each submarket is expressed as:

(1)         $P_t = f(Q_t)$

Furthermore, the generalized market equilibrium model[1] is postulated as:

(2)         $P_t = q [UD_t, \left(\frac{UX^*}{SS^*}\right)_t, \left(\frac{CO}{UU}\right)_{t-1}]$

Where: P is price received by farmers;

Q is quantity demanded in each submarket;

UD is the domestic demand;

$\left(\frac{UX^*}{SS^*}\right)$ is expected export demand (UX*) as the percent of expected total supply (SS*);

$\left(\frac{CO}{UU}\right)$ is ending stock (CO) or beginning stock in the following year ($CI_{t-1}$) as the percent of total usaage (UU).

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[1] The model consists of three equations in a more detailed study. The expected total supply (SS*) is estimated separately from a supply function in a recursive model. The expected export demand (UX*) is treated as an exogeneous variable in the model and is expressed as a function of several exogeneous foreign variables.

Equation (1) assumes that each individual submarket such as domestic, export, total use, and residual stocks is a subset of the total demand. Thus, price flexibility and structural changes in each submarket can be evaluated separately. A dummy variable, (D), is added to test the shift in price functions and a second variable, (QD), which is a product of quantity demanded and the dummy variable is used to test the change in the slope of the curves.

Three assumptions are postulated with respect to equation (2). First, the model assumes that domestic wheat demand is purely a function of market price. Second, the impacts of export demand and total supply on market prices need to be measured on their joint merits and/or combined effects. Therefore, the model assumes that it is the relative changes in the expected export demand (UX*) and the expected total supply (SS*) to which the market is responding. In other words, proportional increases or decreases in expected export demand and expected total supply will not change the market prices. Furthermore, market prices are constantly reacting to the public and private institutions' revised assessments of expected export demand and expected total supply. Third, it is also assumed that the market is responding strongly to the level of ending stocks relative to the total usage, in the preceding year.

Thus, equation (2) is a recursive model at market equilibrium. Clearly, the level of initial stocks is predetermined. It further assumes that the expected total supply is either predetermined or frequently revised with new information and is not a function of current price.

A dummy variable, (D), is also added to equation (2) to measure the shift in the function. In addition, three variables which are the products of the dummy and each of the three independent variables in equation (2) are added to measure the changes in the slope of the functions.

## RESULTS

Estimates of price flexibility in the four demand submarkets are presented in table 1. These submarkets are domestic demand, export demand, the residual stock demand market, and the total use market which includes domestic and export demands. All eight coefficients estimated for the slope of the functions have the hypothesized sign. However, only two of the coefficients, domestic demand and residual stock demand in the 1972-78 period, are statistically significant: domestic demand at the 10-percent and residual stocks at the 5-percent probability levels. The coefficients associated with the dummy variable (D) for these two markets are also significant at the 5-percent probability level. These findings on domestic demand and residual stock demand indicate not only that the demand functions faced by these two markets have shifted to the right, but also that the slopes of the curves have changed significantly in the 1972-78 period. The estimated coefficients are 4 times larger for the latter period than the earlier period: -.85 [i.e., -.62 + (-.23)] vs. -.23 for domestic demand; -.27 vs. -.06 for residual stock demand. These co-efficients suggest that the price response was about 85 cents per bushel for every 100-million-bushel change in domestic demand and 27 cents for every 100-million-bushel change in residual stock demand. Though the

Table 1.  Estimated wheat demand functions, U.S., 1961-1978

| Variable name | Variable notation | Submarket | | | | Domestic and export demand | Domestic, export, and residual stock |
|---|---|---|---|---|---|---|---|
| | | Domestic demand | Export demand | Residual stocks | Total use | | |
| Equation no. | | (a) | (b) | (c) | (d) | (e) | (f) |
| Constant | | 312.81 | 96.50 | 100.53 | 298.10 | 353.91 | 218.57 |
| Quantity | $(Q)_t$ | -.23 (-1.45) | -.01 (.40) | -.06 (.93) | -.11 (.56) | -.25 (-1.54) | -.15 (-1.49) |
| Dummy | $(D)_t$ | 653.78 (2.77)** | 138.72 (.44) | 319.51 (4.21)** | 326.25 (.79) | 232.29 (.66) | -752.17 (-2.89)** |
| Dummy x Quantity | $(QD)_t$ | -.62 (1.98)* | -.01 (-.04) | -.21 (-2.41)** | -.06 (.25) | -.37 (-1.08) | 1.36 (4.06)** |
| Export Supply | $\left(\frac{UX}{SS}\right)_t$ | | | | | -1.06 (-.45) | .09 (.06) |
| Dummy x Export Supply | $D\left(\frac{UX}{SS}\right)_t$ | | | | | 5.68 (1.47) | 4.32 (2.18)** |
| Stock Usage | $\left(\frac{CO}{UU}\right)_{t-1}$ | | | | | | .49 (1.50) |
| Dummy x Stock Usage | $D\left(\frac{CO}{UU}\right)_{t-1}$ | | | | | | -7.12 (-6.58)** |
| Sample size | n | 18 | 18 | 18 | 18 | 18 | 18 |
| R-square | $\bar{R}^2$ | .78 | .60 | .72 | .62 | .79 | .95 |
| Multicol. | m | .64 | .66 | .38 | .67 | .77 | .76 |
| Durban-Watson | D.W. | 2.43 | 1.59 | 1.69 | 1.89 | 2.24 | 2.39 |
| Standard Error | SEE | 44.57 | 60.55 | 50.07 | 58.38 | 43.76 | 20.73 |

Note:  Standard errors in parentheses.  Asterisks denote significant: *for between 5% and 10%; **for below 5%.

coefficient for residual stock demand is lower than the coefficients for the other submarket demands, the impact of fluctuation in residual stocks on market prices is greater than fluctuation from changes in the other submarket demands, because the quantities involved in residual stock demand change are substantially greater.

The coefficients estimated for export demand and total use submarkets are all insignificant. Neither export demand nor total use appear to be price-responsive, and the demand structures do not change between the periods. This suggests that export demand is responding to factors such as production, foreign exchange reserves, and other political factors in the grain importing countries and that changes in export demand will tend to shift the demand function.

Equation (2) is the market equilibrium model and is estimated by equation (f) in table 1 with seven independent variables. It includes three groups of variables, UD and DUD, $\left(\frac{UX}{SS}\right)$ and $D\left(\frac{UX}{SS}\right)$, $\left(\frac{CO}{UU}\right)_{t-1}$ and $D\left(\frac{CO}{UU}\right)_{t-1}$ and the dummy variable D. The second variable in each group is used to test the changes in the slope of the demand function. All of the variables associated with the 1961-71 period [i.e., the first variable in each group UD, $\left(\frac{UX}{SS}\right)$, and $\left(\frac{CO}{UU}\right)_{t-1}$ ] have the hypothesized sign but all are statistically insignificant at the 10-percent probability level. This suggests that market prices during this period have little relationship with the level of domestic demand, export demand, initial stocks, or the total supply.

All the variables associated with the 1972-78 period [i.e., the second variable in each group, DUD, $D\left(\frac{UX}{SS}\right)$, and $D\left(\frac{CO}{UU}\right)_{t-1}$ ] have the hypothesized sign and are statistically significant at the 1-percent probability level except the domestic demand DUD. The market price appears to be strongly influenced by the expected export demand expressed in terms of expected total supply. The results in table 1 indicate that a 1-percent increase in the expected export demand expressed in terms of expected total supply would result in a 4.4-cent (4.32 + .09) increase in prices per bushel. A proportional decline in expected total supply, with expected export demand held constant, would have the same price impact. Current forecasts point to 1979/80 total U.S. wheat supplies of 3.07 billion bushels and exports of 1.33 billion bushels (USDA). An increase in expected export demand of 30 million bushels or a decrease in expected total supplies of 70 million bushels would decrease the ratio of expected export demand and expected total supply by 1 percent, which in turn will increase market prices by 4.4 cents per bushel. The magnitude of impacts would become greater as the ratio becomes smaller.

The current market price is most strongly affected by the level of beginning stocks expressed in terms of total use in the preceding year. A 1-percent increase in the beginning stocks relative to the previous year's total usage will tend to depress market prices by as much as 7.12 cents. This clearly suggests that the magnitude and momentum of the demand force in the previous year will carry to the current year, especially during the early part of the year.

## CONCLUSION

A few interesting findings emerge from this analysis.

First, any analysis of grain supply and demand in general, and of wheat supply and demand in particular, needs to take into account the structural changes in that market during the period concerned. The structural changes in the wheat demand market were so enormous that any attempt to pool the 1961-78 historical data without incorporating a structural variable would certainly lead to a bias estimator. The structural changes in the wheat market appear to be overwhelmingly on the slope of the function rather than on the shift of the curve.

Second, since domestic demands are relatively stable and are basically a function of price, any increase in export demand will reduce the level of residual stocks. Export demands therefore need to be viewed in the context of the relationship between export demand and the market's desire to hold residual stocks. In the last few years, total supply of wheat has been increasing at a faster pace than export demand. Consequently, market prices have been drifting downward. A policy implication of this analysis is that stabilization policies need to focus on the relative growth of export demand and total supply. Stable market prices and, thus, stable farm income can be maintained only when the growth in supply is in line with the growth in export demand.

Finally, market prices appear to be extremely sensitive to the level of beginning stocks relative to the previous year's usage. This is particularly true during the beginning of the season as our production response will not be known until late spring when the planted acreage is

assessed. Thus, a more vigorous analysis of the relationship between ending stocks and other economic factors may provide useful informaion for policy formation and program development.

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## REFERENCES

Grennes, T., P. R. Johnson, and M. Thursby. "Insulating Trade Policies Inventories, and Wheat Price Stability." Amer. J. Agr. Econ. 60(1978): 132-34.

Johnson, D. G. "World Agriculture, Commodity Policy, and Price Variability." Amer. J. Agr. Econ. 57(1975): 823-28.

Shei, S.Y., and R. L. Thompson. "The Impact of Trade Restrictions on Price Stability in the World Wheat Market." Amer. J. Agr. Econ. 59(1977): 629-38.

U.S. Department of Agriculture. Agricultural Supply & Demand Estimates. World Food and Agricultural Outlook and Situation Board No. 99, March 11, 1980.

Yeh, C. J., L. G. Tweeten, and C. L. Quance. "U.S. Agricultural Production Capacity." Amer. J. Agr. Econ. 59(1977): 37-48.

Zwart, A. C., and K. D. Meilke. "The Influence of Domestic Pricing Policies and Buffer Stocks on Price Stability in the World Wheat Industry." Amer. J. Agr. Econ. 61(1979): 434-45.