MANAGING BUFFER STOCKS TO STABILIZE WHEAT PRICES

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ABSTRACT

A wheat buffer stock simulation model is used to add random deviations of wheat yields and exports to projected supply and demand conditions for 1976-82. The result is a useful analytical tool for policy analysis—especially for the analysis of questions about price and income stability where deviations of production and use from the mean, rather than the value of the mean, are of primary interest.

A simple buffer stock management rule is examined. Wheat buffer stocks would be purchased by a U.S. stocks management agency whenever the market price dropped below a specified purchase price, and stocks would be sold whenever the market price exceeded a specified sale price. The impact of alternative stock levels and alternative purchase and sale prices on the level and variation of supply, domestic and foreign sales, Government costs, and farm income are examined.

Key Words: Wheat stocks, buffer stocks, wheat price stabilization.

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SUMMARY

A simulation model, covering 1976-82, indicates that with an initial wheat buffer stock of 400 million bushels, the frequency of wheat exceeding $4.50 a bushel would be only 6 percent, compared with 29 percent in the absence of buffer stocks. As the initial level of buffer stocks increases, both price variation and the incidence of extremes decrease. The average wheat price, however, falls with increased sizes of buffer stocks.

Gross farm income exhibits less variation under the buffer stocks alternative because there is less variation both in wheat price and quantity produced. However, there is a likelihood that wheat producers would bear a disproportionate share of the costs of the buffer stock program through the lowered average price and value of production. On the other hand, wheat buyers would gain from the lower average price.

Unless the buffer stock leads to an increase in the volume of exports, these results suggest that the program would benefit our foreign customers at our expense. They would have the security of knowing a reserve stock was available, plus they would pay a lower average price. However, it should not be difficult to use a buffer stock in export-increasing ways. Also, the United States would perhaps be willing to bear part of the cost of providing some international price stability.

The average annual cost of a buffer stock program could be small. The simulation shows that in a typical year, the expected costs of the stock management program would be under $200 million, but there is also a small probability that Federal budget requirements could exceed $2 billion in years of large stock purchases unless limits are imposed.

The buffer stock purchase and sale prices used in the simulations were specifically set so that the stock activity would be well behaved over the 7-year study period. Results show that misspecifications of these prices can lead to the undesirable results of either no program effectiveness or very large Government costs, unless the buffer stock program has self-corrective elements.

The simulations are based on 3,500 observations that add random deviations of wheat yields and exports to projected supply and demand conditions for 1976-82. This report focuses on the price stabilization effects of buffer stocks, but the model also provides a basis for evaluating in money terms the costs and benefits for other objectives, such as reduced variation in farm income, steady supplies for foreign customers, and assured supplies for disaster relief. The model is particularly useful for the analysis of questions about price and income stability where deviations of production and use from the mean, rather than the value of the mean, are of primary interest.

MANAGING BUFFER STOCKS TO STABILIZE WHEAT PRICES

by

Jerry A. Sharples, Rodney L. Walker, and Rudie W. Slaughter, Jr.[1]

INTRODUCTION

Whether the Federal Government should store a buffer stock of grain is an economic and political issue. The justification for publicly controlled buffer stocks is discussed and evaluated in a report by the Food and Agriculture Organization (FAO) of the United Nations (*11*), by Sharples and Slaughter (*8*), and by D. Gale Johnson (*5*).[2] It is generally agreed that a buffer stock can meet a number of objectives. But the costs and benefits have not been fully examined. The pros and cons depend on assessment of: the merits of the objectives, the ability of a buffer stock to achieve the objectives, who pays the costs, and who gets the benefits. The objectives of buffer stock programs may be to:

1. Reduce variation of food prices,
2. reduce variation in farm income,
3. assure dependable supply to foreign customers, and
4. assure supplies for disaster relief.

That a single buffer stock, appropriately managed, can accomplish these objectives simultaneously and more efficiently than would separate buffer stocks for each objective is obvious. It is not obvious, however, how different buffer stock management rules affect average, or expected values of, farm income, food costs, export sales, and Treasury costs. High farm income, low food costs, large export sales, and low Treasury costs are mutually conflicting, though widely held, objectives. Although none of these alone is an appropriate objective for a buffer stock program, the management of the program almost certainly will affect all of them.

This report discusses a simulation model designed to evaluate these effects as well as effects on price and supply variance. The focus here is on a small portion of the total buffer stock question: stabilizing the commercial U.S. wheat market using a publicly controlled buffer stock. The important issue of public vs. private ownership of stock is not discussed nor are the issues of stock for world food aid or an international grain reserve. A relatively simple wheat market simulator is described and demonstrated. It is used to estimate the impact of several buffer stock management rules on the level and variability of farm prices and income, Government costs, exports, and domestic consumption.

The model can be used to evaluate quickly and cheaply certain effects of wheat buffer stock programs. It is being expanded to include other grains.

[1] The authors are agricultural economists, Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture. Sharples and Walker are stationed at Purdue University, West Lafayette, Ind., and Slaughter is stationed at the University of Missouri, Columbia, Mo. The assistance of Forrest Holland is greatly appreciated.

[2] Italicized numbers in parentheses refer to references listed at the end of this report.

WHEAT MARKET SIMULATOR

Focus

To examine the issue of buffer stocks and wheat price stabilization, we focus on the distribution of possible future events rather than just examining the most likely events. It is the deviation from the most likely that generates the need for a buffer stock. Two major sources of annual variability in the U.S. wheat market are wheat yields and export demand. The wheat market simulator is built around these premises.

This wheat market simulator is an abstract of the U.S. wheat market designed to analyze buffer stock programs.[3] It contains shortrun (annual) supply and

[3] The model is similar to the one used by Tweeten, Kalbfleisch, and Lu (*10*).

demand functions for 1976 through 1982. The supply function incorporates a linear cobweb production response—that is, production this year is a linear function of last year's average wheat price. The demand functions approximate constant price elasticity. Both supply and demand functions contain random disturbance terms, giving a distribution of shortrun supply and demand curves for each of the 7 years and, consequently, a distribution of annual equilibrium prices for each of the 7 years.

The simulator is specifically designed to analyze Government buffer stock management rules intended to reduce market price variability. The shortrun (annual) equilibrium price, P, varies through time because of shifts in the supply and demand functions and random disturbances (fig. 1). The stock management rules ex-

Equilibrium price over time

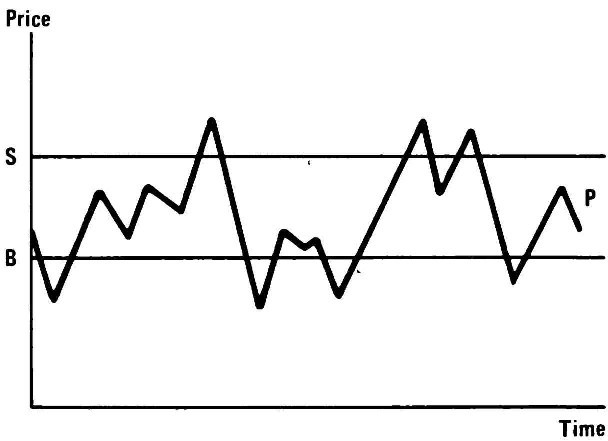


Figure 1.

amined in this report are defined in terms of alternative buffer stock purchase prices (B) and buffer stock sales prices (S). When the market price drops below B, wheat is purchased by the stock manager at B until the market price is raised to B. When the market price exceeds S, the stock manager sells wheat at S until either the market price is at equilibrium at S or until the buffer stock is exhausted.[4] [5] This arrangement differs from the loan program of current legislation in that the buffer stock agency has immediate control of the grain by virtue of a direct purchase.

Operation

The general operation of the simulator from year to year and from iteration to iteration is illustrated in figure 2. Starting with a selection of random numbers to

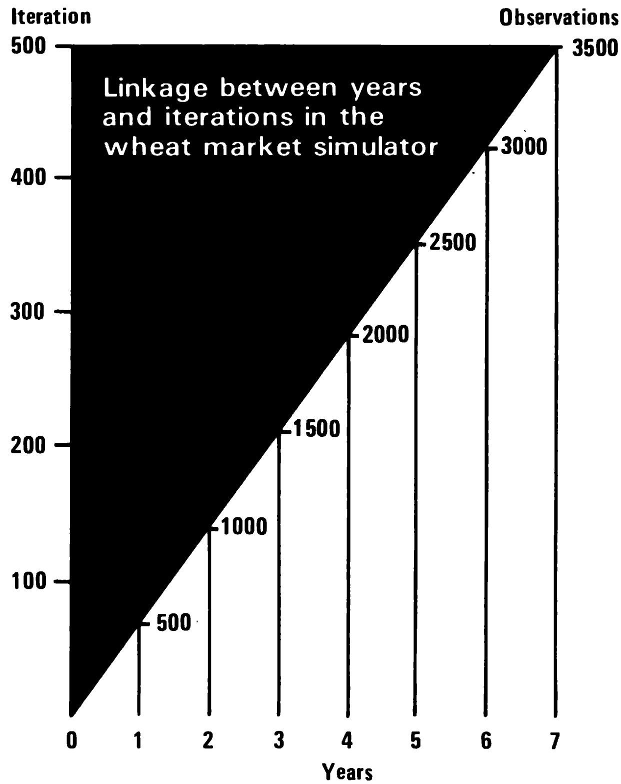


Figure 2.

use in the supply and demand equations in the first 7-year iteration, the model computes production, use, average annual market price, buffer stock purchases or sales, and other items for year 1 (1976). The year 1 market price and ending buffer stock are used to compute year 2 and so on through year 7. Information from each year is stored for later analysis. The second iteration of the 7 years begins with the same set of starting values but a new set of random numbers. The 7-year sequence is repeated 500 times.[6] Results are then summarized for each year and for the 7-year period. Most results reported here are obtained from the summary of the 7-year period.

[4] The size of the buffer stock is assumed not to affect the market price when the market price is between B and S—that is, participants in the market are assumed to have confidence that the stock management agency will follow the rules as specified in the simulation model. This is a controversial assumption. Some opponents of a publicly controlled buffer stock say there is no way to prevent the buffer stock from depressing prices.

[5] There are alternative ways to specify the purchase and sale prices. For example, Mayer (*6*) suggests a supply function be used for release of buffer stocks wherein for each increment of the stock released, the release price would be increased a specified increment. Other rules are listed in Walker and Sharples (*12*).

[6] The 500 iterations were adequate to give acceptably small sampling error. The computer cost of one simulation of 500 iterations was under $2.00.

Supply and demand functions used in the simulator approximate reasonable expectations of the underlying supply and demand conditions in the wheat market over next 7 years.[7] Random variance in wheat yields and foreign commercial demand for U.S. wheat are added to the supply and demand functions in the simulator.

Supply

In the simulator, wheat production is calculated:

$$A_t = 49.0 + 6.0\,(P_{t-1}/I_t),$$

$$H_t = 0.91A_t, \text{ and}$$

$$W_t = Y_tH_t = (M_t + N)H_t,$$

where:

A is planted area of wheat (million acres),

P is the average annual nominal price of wheat (dollars per bushel),

I is a price deflator to adjust the nominal price of wheat to its 1976 equivalent. An increase of 6 percent per year in prices of inputs is assumed for the 7-year period. Thus, the values of the deflator (I) for each year of the 7-year period are I = 1.00, 1.06, 1.1236, 1.1910, 1.2625, 1.3382, and 1.4185, respectively.

t is time where 1976 = 1, 1977 = 2, . . . , 1982 = 7,

H is harvested area of wheat (million acres),

W is wheat production (million bushels),

Y is yield (bushels per acre),

M_t is projected average yield (bushels per acre) in year t, with M in 1976 equal to 32.1 and increasing each year thereafter by 0.6 bushel, and

N is a normally distributed random variable with a zero mean and a standard deviation of 2.0 bushels per acre.

For example, by assigning $M_{76} = 32.1$, $I_{76} = 1.0$, and N = 0, the supply function for 1976 is:

$$W_{76} = 1431 + 175P_{75}.$$

[7]These estimates are based upon results from Barr (*1*), Garst and Miller (*3*), Hoffman (*4*), Ray and Richardson (*7*), unpublished USDA projections, and authors' estimates.

Because of the trend in yields, this supply curve will shift to the right each year. An increase in the value of the deflator will shift the curve to the left relative to where it would be were the nominal price also the real price.

Demand

Constant elasticity demand functions are used in the wheat market simulator. Thus, demand can be specified in terms of a price-quantity point and an elasticity. Demand for wheat is divided into four components: food, feed, seed, and export demand. A price-quantity point and elasticity is specified for each. In real price terms, these demand functions are assumed to be invariant over the 7-year simulation.

The shortrun wheat demand curves used in the simulator are defined by the following price-quantity points and elasticities:

Demand	Quantity	Price	Price elasticity
Food	535 mil. bu.	\$3.50/bu.	-.10
Feed	200 mil. bu.	\$3.50/bu.	-.35
Seed	80 mil. bu.	\$3.50/bu.	0
Export	1,100 mil. bu.	\$3.50/bu.	-1.00

Thus, the annual demand equations are:

Food $B = 606P^{-.1}$

Feed $F = 310P^{-.35}$

Seed $S = 80$

Export $X = 3850P^{-1.0}$

where quantities are in million bushel units.

The price elasticity of export demand is somewhat arbitrarily set at -1.0. Tweeten (*9*) estimated an intermediate-run price elasticity of wheat export demand of -2.8, some analysts have suggested it should be -0.5, and Barr (*1*) assumed a perfectly inelastic export demand. We tested several elasticities in the wheat simulator, and our subjective evaluation of the results led us to choose -1.0.

The simulator uses only linear functions, so the constant elasticity functions are approximated by linear segments, as shown in figure 3. The equations for the linear demand functions are:

$$X = 1263 - 103P + R \text{ when } 4.50 \leq P,$$
$$X = 2285 - 330P + R \text{ when } 2.50 < P < 4.50,$$
$$X = 4343 - 1153P + R \text{ when } P < 2.50,$$
$$T = 2120 - 120P + R \text{ when } 4.50 \leq P,$$

Shortrun demand for U.S. wheat used in the wheat market simulator

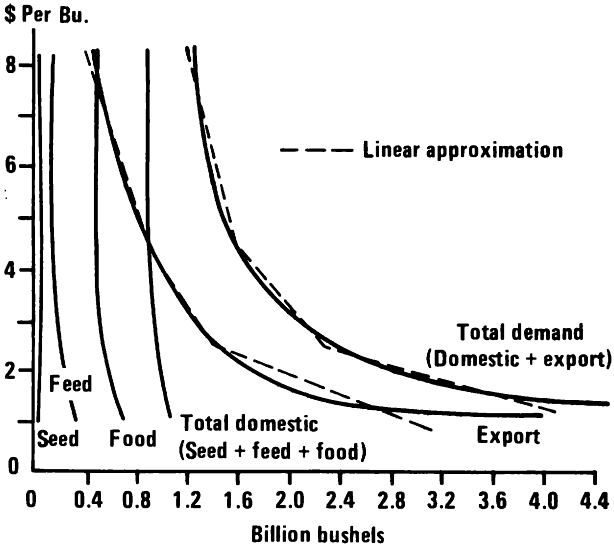


Figure 3.

$$T = 3245 - 370P + R \text{ when } 2.50 < P < 4.50, \text{ and}$$
$$T = 5437 - 1247P + R \text{ when } P \leqslant 2.50,$$

where:

T is total annual wheat use (million bushels),

R is a normally distributed random number with a zero mean and a standard deviation of 400 million bushels, and

P is the average annual nominal price of wheat (dollars per bushel).

Since program administrators and legislators usually pose questions in terms of nominal prices, a price deflator is incorporated in the demand equation for wheat. The deflator enters the demand functions as follows:

$$Q_t = b_0 - b_1(P_t/I_t) + R$$

where I deflates the nominal price, P_t, to its 1976 equivalent. Wholesale prices of all goods are assumed to increase 6 percent per year from 1976 to 1982; thus, the values of I are the same as in the supply equations.

Characteristics of Simulator

By taking the expected value of the above system of supply and demand equations (that is, setting R = N = O, and solving for P_t), the implied shortrun equilibrium price-quantity is traced over the 7 years. This is shown in table 1 in both nominal and real prices. Note that in real

Table 1—Equilibrium wheat prices and quantities produced, based on supply and demand equations from the wheat market simulator[1]

Year	Nominal prices[2]		Real prices[3]	
	Price	Quantity	Price	Quantity
	Dollars/ bushel	*Million bushels*	*Dollars/ bushel*	*Million bushels*
1976	3.13	2,089	3.13	2,089
1977	3.61	1,985	3.32	2,016
1978	3.57	2,069	3.13	2,089
1979	3.79	2,067	3.12	2,090
1980	3.89	2,104	3.02	2,126
1981	4.06	2,123	2.97	2,145
1982	4.20	2,150	2.90	2,172

[1] P_{75} = $3.75 and R = N = 0 in all equations.
[2] $I_{76} = 1.0$, $I_{77} = 1.06$, $I_{78} = 1.1236$, $I_{79} = 1.1910$, $I_{80} = 1.2625$, $I_{81} = 1.3382$, and $I_{82} = 1.4185$.
[3] $I_t = 1.0$ for all t.

prices, the price series traces a cobweb time path that converges on a downward sloping price trend. The downward trend is caused by the annual increase in wheat yield, which shifts the supply curve to the right. In 1982, the real price of wheat is $2.90 per bushel for the system of equations. Quantity does not change much from year to year because of the inelastic nature of supply.

With the assumed 6-percent annual inflation, however, the nominal wheat price exceeds $4.00 per bushel after 1981, even though the quantity produced and consumed changes little from the no-inflation quantity. By 1982, the nominal price exceeds the real price by $1.30 per bushel.

The two random variables in the demand and supply equations, R and N, are assigned values drawn at random from their respective distributions. Thus, for any one year the equilibrium values of price and quantity will also have a distribution.

NO-BUFFER STOCKS SIMULATION

Comparison Base

First, the wheat market simulator is run without a buffer-stock program. This simulation provides a base for comparison with solutions derived from alternative assumptions about buffer stocks. The simulation is started with a 1975 wheat price of $3.75 per bushel. Means of key indicator variables and their distributions are summarized in table 2.

Production trends upward over the 7 years because of the annual increase in wheat yields. The annual wheat price mean is lowest in 1976 and climbs to $4.55 in 1982, primarily because of the inflation factors in the model. Since there is no allowance for carryover stocks in this simulation, domestic use and exports sum to total production each year.[8]

Frequency Distributions

Over the 7-year period, 3,500 observations are made of each indicator variable. The distribution of the observations on annual wheat price in the absence of buffer stocks is shown in figure 4. The skewness of the price distribution is caused by the shape of the demand function. The steep slope for small quantities causes the tail of the price distribution in figure 4, top, to cover some very high prices, whereas the flat slope for large quantities demanded tends to cut off low prices. With continuous linear demand and supply curves, the shortrun equilibrium price would be distributed normally because of the additive form of the normally distributed random variables appearing in the demand and supply equations.

[8] In each simulation, stocks held by private firms are assumed constant at pipeline levels. An issue needing further research is whether the stock activities of private firms would increase or decrease the variances of prices and quantities relative to those in the no-buffer stocks simulation. Competitive market theory suggests that in the absence of a publicly held buffer stock, there would be more privately owned stocks. Private stocks management may reduce price variability relative to the no-buffer stocks results reported here, but not necessarily so. Processors would tend to cover their needs within the production period, but there is nothing to suggest deliberate plans to carry stocks into future production periods. Speculators might do so, but wouldn't they tend to hold during price run-ups and dump when price turned down? Breimyer (*2*) suggests that private stockholders would tend to increase price variability.

Table 2—Expected values, frequencies, and coefficients of variation for selected items, wheat market simulator, 1976-82, no-buffer stocks alternative[1]

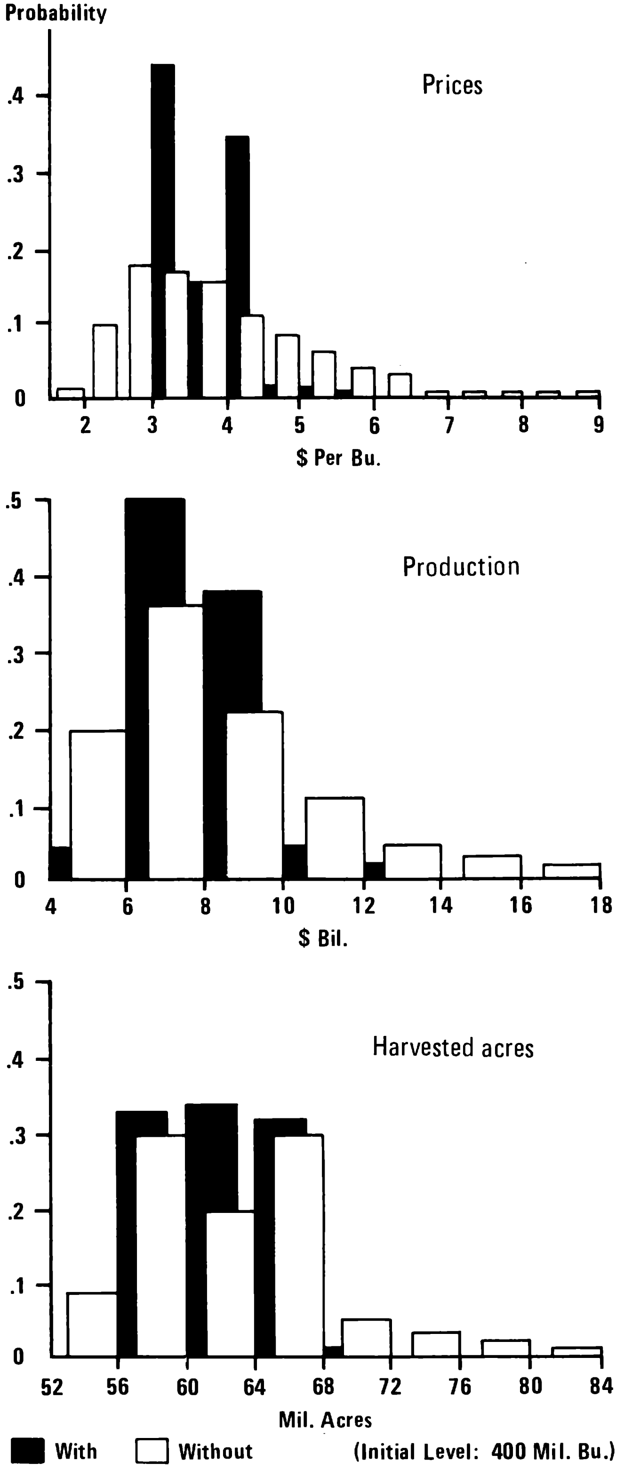
Item	Unit	1976	1977	1978	1979	1980	1981	1982	1976-82
Mean value:									
Harvested area	Thous. acres	65,074	62,273	63,780	61,740	62,791	61,281	61,340	62,611
Yield	Bu./acre	32.0	32.7	33.3	33.9	34.6	35.2	35.6	33.9
Production	Mil. bu.	2,083	2,037	2,120	2,095	2,173	2,158	2,186	2,122
Domestic use	do.	831	823	836	830	840	839	841	834
Exports	do.	1,252	1,214	1,284	1,265	1,332	1,318	1,345	1,287
Price per bushel[2]	Dols.	3.43	3.95	3.74	4.21	4.09	4.35	4.55	4.04
Value of production[3]	Mil. dols.	7,103	7,859	7,719	8,598	8,666	9,207	9,744	8,414
Frequency of:									
Price under $3.00 per bu.	Percent	46	36	37	31	27	17	10	29
Price over $4.50 per bu.	do.	11	25	22	34	31	38	42	29
Value of production under $6 billion	do.	42	29	27	19	12	5	2	20
Value of production over $14 billion	do.	4	6	3	7	5	7	8	6
Coefficient of variation of:									
Production		.06	.13	.14	.13	.14	.12	.12	.13
Exports		.10	.19	.21	.20	.21	.19	.18	.19
Value of production		.37	.40	.35	.39	.35	.35	.33	.38
Value of exports		.41	.43	.38	.43	.37	.39	.36	.41
Price		.39	.44	.41	.44	.40	.39	.38	.42

[1] Each item is calculated from 500 observations for 1 year or from 3,500 observations (500 per year for 7 years) for the 7-year period.

[2] Expected value of price is the mean of the observations of price and will always exceed the expected value of the value of production divided by the expected value of quantity of production because the demand curves are convex.

[3] Market price times production.

Distribution of annual wheat prices, value of production, and harvested acres, with and without buffer stocks*



* *3,500 observations, 1976-82*

Figure 4.

The distribution of the value of annual wheat production with no buffer stock program is also skewed (fig. 4). Most observations fall between $6 billion and $10 billion, but 6 percent of the observations exceed $14 billion.

There is an 80-percent chance that harvested area of wheat would be between 56 million and 68 million acres, with an 11-percent chance of its exceeding 68 million acres (fig. 4).

Variation

Over the 7-year simulation period, the coefficient of variation on production is 0.13, with yields being the major source of variation.[9] During 1960-72, when the wheat market was fairly stable, the coefficient of variation on production was 0.12. The coefficient of variation on quantity exported was 0.15 during that period, while for 1976-82 it is 0.19. This value for the simulated period is not as high as might be expected because in the no-buffer stock solution of 1976-82, the quantity exported is constrained by the quantity produced and the quantity consumed domestically. Again, the quantity consumed domestically is very stable, primarily because of the inelastic nature of the domestic demand function. Thus, in the absence of stocks, the quantity exported can vary only slightly more than the quantity produced. Were stocks available, the quantity exported could vary more.

The coefficients of variation for quantity and value of production and exports and for price are all lower in 1976 than in later years (table 2). For example, the coefficient of variation of production is .06 in 1976 and .12 to .14 in later years. The reason is that in the 1976 supply equation, N (the random disturbance of yield) is the only source of variation. After 1976, P_{t-1} (lagged price) is also a source of variation. The low variation of production the first year results in low variation in equilibrium price and quantity exported.

As expected, price variation is much higher in the no-buffer stocks simulation (0.42 coefficient of variation) than in the historical period (0.17).

[9] The coefficient of variation is the sample standard deviation divided by the sample mean. This statistic is a pure number which allows comparison of variability for items measured in different units and for items of different magnitudes.

Management Rule

The next objective is to define and apply a buffer stock management rule to the simulator and observe its impact on the indicator variables. When the equilibrium price drops below the buffer stock purchase price, stocks are purchased from the market by the stock management agency, and when the equilibrium price goes above the stock sale price, buffer stocks are sold (fig. 1). The flow chart (fig. 5) shows the sequence of decisions built into the simulator.

A stock management rule requires resolution of two issues. First, what should be the difference between the purchase price B and the sale price S? The smaller the difference, the greater the frequency of purchases and sales by the stock manager and the greater the constraint of the market price. A larger difference permits more market freedom but also less price stability. Second, at what level should B and S be defined? If set too high relative to the expected shortrun equilibrium price, the buffer stock will tend to increase over time. On the other hand, if the prices are too low, stocks will tend to be at low levels, increasing the probability of failure to achieve price stability objectives.

For the initial set of buffer stock simulations, purchase price is set at $3.00 per bushel and the release price at $4.50. These bounds were chosen somewhat arbitrarily. Data from the no-buffer stocks simulation shows that 29 percent of the observations on price fall below $3.00 and 29 percent fall above $4.50, including that over the 7 years, sales should nearly balance purchases. Also, 42 percent of the price observations fall between $3.00 and $4.50, indicating no Government stock action.

The 7-year simulations start with four initial levels of buffer stocks: none, 200, 400, and 600 million bushels. Of course, at the beginning of the 1976 marketing year there were no publicly held buffer stocks. But since there is a trade-off between price stability and Government costs as the size of the stock is increased, analysis of these alternative starting levels should help answer the question, "To what level should a buffer stock be allowed to accumulate?"

Variance Reduced

Simulation results suggest that a buffer stock program can effect a major reduction in price variation (table 3). As the initial level of buffer stocks increases, the coefficient of variation on price and incidence of price extremes decreases. Over the 3,500 observations, the frequency of the wheat price exceeding $4.50 is only 6 percent in the case where the initial buffer stock is 400 million bushels, compared with 29 percent for the no-buffer stock simulation (fig. 4).

The buffer stock program also reduces the variation in harvested area (fig. 4) and quantity produced. Thus, the reduced variability in both price and production results in a major reduction in variation in gross income to wheat producers (fig. 4).

The variation in quantity exported, however, increases slightly with the buffer stock programs. Stock sales and purchases allow quantities exported to fluctuate in response to changing foreign demand. Thus, a buffer stock program allows the quantity exported to expand or contract while buffering the price impact.

Stock Activity

A detailed examination of the simulation results, starting with a buffer stock of 400 million bushels of wheat, shows how the stock activity works. Over the 7 years, there is a 27-percent chance that stock will be purchased and a 28-percent chance that stock will be sold. There is an 8-percent chance that no buffer stocks are available at the beginning of a year. The expected size of the buffer stock in any one year is 562 million bushels, with 25 percent of the observations being over 800 million bushels (fig. 6). The mean value of annual storage and interest costs is $245 million, and the annual net cost after figuring the cost of purchases and the return from sales is $171 million. The distribution of annual Government costs has a wide range, with 12 percent of the observations exceeding $1 billion, while in many cases net profits are made by sales from inventory (fig. 7).

In the simulation that starts with a buffer stock of 400 million bushels, the average size of the buffer stock by the end of 1979 is 628 million bushels, but it then decreases to 456 million bushels by 1982. This initial increase and subsequent decrease occur because the average wheat price rises over the period in response to inflation factors in the supply and demand equations, while the stock purchase and sale prices remain constant. Beyond the 7-year period, the stock would tend to become depleted unless the price bounds were changed or the expected market price dropped. The pattern of building stocks to 1979 and then declining stocks shows up in all four buffer stock simulations for the same reason.

By starting the 7-year period with a larger buffer stock, the following happens:

(a) the probability of being out of buffer stocks is reduced,
(b) the probability of buffer stock sales is increased,
(c) price variability is reduced, and
(d) the cost of the buffer stock program is increased because the increased cost of carrying a larger stock exceeds revenue increases from sales by the stock management agency.

Flow chart of wheat stocks management simulation model (Buffer stock example)

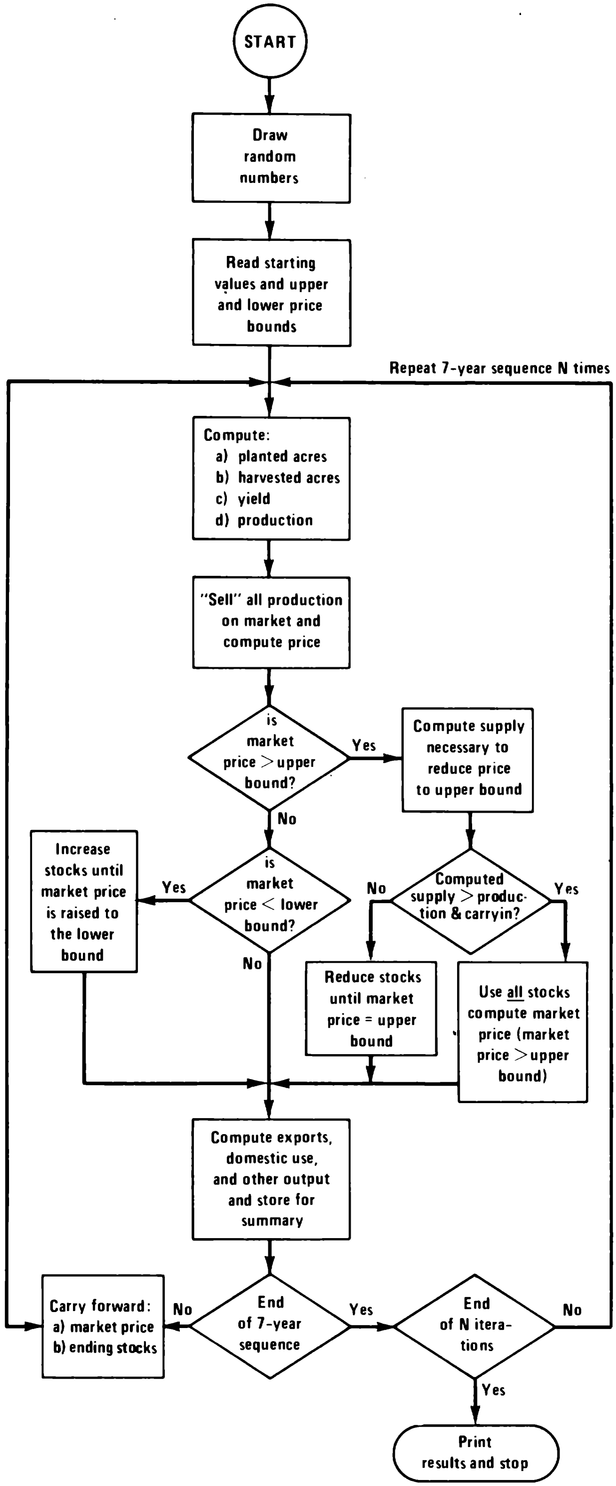


Figure 5

Table 3—Mean values, frequencies, and coefficients of variation for wheat market simulations, 1976-82

Item	Unit	No buffer stock program	Beginning buffer stocks of: 0 mil. bu.	200 mil. bu.	400 mil. bu.	600 mil. bu.
Mean value:						
Harvested area	Thous. acres	62,611	62,300	61,982	61,812	61,721
Production	Mil. bu.	2,122	2,110	2,100	2,094	2,091
Domestic use	do.	834	832	833	834	835
Exports	do.	1,287	1,237	1,246	1,252	1,256
Buffer stock	do.	---	302	409	562	739
Buffer stock end of 1979[1]	do.	---	376	475	628	809
Buffer stock end of 1982[1]	do.	---	293	346	456	602
Price per bushel	Dollars	4.04	3.92	3.85	3.80	3.77
Value of production	Mil. dols.	8,414	8,215	8,035	7,926	7,862
Value of exports	do.	5,113	4,939	4,894	4,862	4,842
Storage and interest costs[2]	do.	---	124	175	245	325
Net U.S. Treasury outlay[3]	do.	---	185	153	171	218
Frequency of:						
Buffer stock purchase	Percent	---	28	27	27	27
Buffer stock sale	do.	---	21	27	28	28
Zero buffer stock	do.	---	32	14	8	5
Buffer stock under 200 mil. bu.	do.	---	51	38	17	10
Buffer stock over 800 mil. bu.	do.	---	10	14	25	40
Price over $4.50 per bushel	do.	29	14	10	6	4
Net U.S. Treasury outlay:						
Zero or negative (profits)	do.	---	44	31	27	25
Over $500 million	do.	---	21	22	25	29
Over $1,000 million	do.	---	12	12	12	13
Coefficient of variation:						
Harvested area		.11	.08	.06	.06	.05
Production		.13	.10	.08	.08	.07
Exports		.19	.20	.20	.20	.21
Value of production		.38	.27	.23	.21	.19
Value of exports		.41	.40	.38	.36	.35
Price		.42	.29	.24	.22	.20

[1] Each item is calculated from 3,500 observations except buffer stocks at the end of 1979 and 1982. These are calculated from 500 observations.

[2] Storage charge of 20 cents per bushel per year plus 8 percent interest.

[3] Storage and interest charges plus value of purchases minus value of sales.

Price Effects

The four buffer stock simulations show that the average wheat price falls as the size of buffer stocks increases. A major cause is the shape of the demand curve. For example, a 100-million-bushel buffer stock purchase in one period will increase price 27 cents at the $3.00-per-bushel market price level, whereas a 100-million buffer stock sale in a second period will decrease price 83 cents at the $4.50 stock sale price. Thus, the average price on all wheat sold in the two periods would be reduced 28 cents (.83 - .27)/2, relative to the free market price.

Who Gains and Who Loses

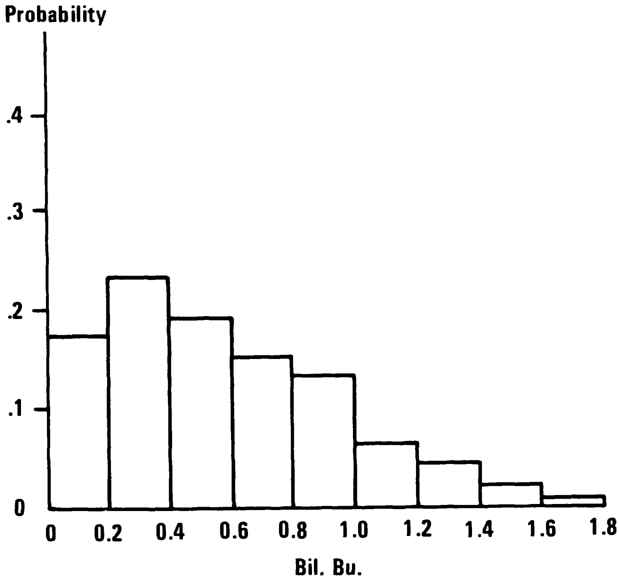
The size of initial buffer stocks causes little change in the average quantity of wheat produced or used. But since the buffer stock alternatives tend to reduce the price of wheat, the mean of both production and export value fall as the size of initial buffer stocks increases.

Thus, the simulation results show that because of reduced price variability, producers lose net income while domestic and foreign buyers benefit by paying less. With an initial buffer stock of 400 million bushels of wheat, the simulation indicates that the mean value of gross wheat sales by producers would be $488 million, or 6 percent, less than if there were no buffer stocks (table 4). Production was down only 1 percent (table 3). The benefits of cheaper wheat go to both domestic and foreign consumers. The reduction in expenditures for domestic consumers is virtually all due to lower price. For foreign consumers, half the reduction is due to smaller quantity and half to lower price.

Consequence of Misspecified Prices

The purchase and sale prices in the stock management rules discussed above were specifically set so that the quantity purchased would approximately equal the quantity sold by the agency. The average buffer stock neither tended toward very large quantities nor very small quantities over the 7 years. But in the real world,

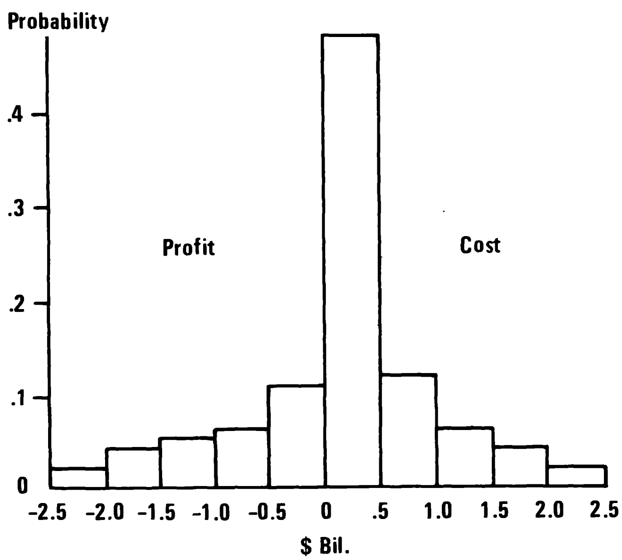
Distribution of size of buffer stocks, buffer stock solution with initial stock level of 400 million bushels*



* *3,500 observations, 1976-82*

Figure 6.

Distribution of net U.S. Treasury outlay, buffer stock solution with initial level of 400 million bushels*



* *3,500 observations, 1976-82 includes interest and storage costs plus sales minus purchases*

Figure 7.

Table 4—Average value of wheat production and use, no-buffer stocks simulation and buffer stock simulation, 1976-82 annual average[1]

Item	No buffer stocks	Buffer stocks	Difference
	Million dollars	*Million dollars*	*Million dollars*
Production.	8,414	7,926	-488
Domestic use . . .	3,301	3,040	-261
Exports.	5,113	4,862	-251
Buffer stocks[2] . . .	0	24	24

[1] Size of buffer stocks at the beginning of the simulation is assumed to be 400 million bushels.

[2] Buffer stock inventory increases an average of 8.0 million bushels per year over the 7 years. With a purchase price of $3.00 per bushel, the buffer stock inventory increases in value by an average of $24 million per year.

it would be easy to misspecify purchase and sale prices. As an example of what can happen over time when buffer stock purchase and sale prices are out of line with a market equilibrium price, one simulation is run with wheat purchase and sale prices set low relative to the no-buffer stocks price, and another is run with the prices set high. The results, compared with the $3.00-$4.50 results obtained previously, are shown in table 5.

Table 5—Summary of effect of wheat buffer stock simulation purchase and sale prices on selected items, 1976-82 annual average[1]

Item	Unit	Price relative to free market price		
		Low[2]	Centered[3]	High[4]
Mean value:				
Production.	Mil. bu.	2,091	2,094	2,213
Domestic use . . .	do.	838	834	803
Exports	do.	1,310	1,252	992
Buffer stock end of 1982	do.	5	456	3,322
Price per bushel . .	Dollars	3.85	3.80	4.66
Net Treasury cost	Mil. dols.	[5] -154	171	3,021
Frequency of:				
Buffer stock purchase	Percent	1	27	80
Buffer stock sale	do.	26	28	5
Zero buffer stock .	do.	66	8	0
Coefficient of variation of:				
Production.		.11	.08	.07
Quantity exported.		.16	.20	.38
Price		.37	.22	.09

[1] Size of buffer stocks at the beginning of the simulation is assumed to be 400 million bushels.

[2] Low buffer stock purchase price is $2.00 per bushel. Low buffer stock sale price is $3.50.

[3] Centered buffer stock purchase price is $3.00. Centered buffer stock sale price is $4.50.

[4] High buffer stock purchase price is $4.50. High buffer stock sale price is $6.00.

[5] On the average, cash surplus is generated because sales exceed interest, storage costs, and purchasing cost.

When the buffer stock purchase and sale prices are set low, the buffer stock tends to be depleted over the 7 years. The probability of a purchase being made is very low, while the probability of having no buffer stock in any one year is relatively high. Also, the expected buffer stock is only 5 million bushels by the end of 1982 (table 5)—an amount which would have only a very small impact on price variability.

With high purchase and sale prices, buffer stocks tend to accumulate. With the purchase price set at $4.50 and the sale price set at $6.00, average buffer stocks by the end of 1982 are 3,322 million bushels of wheat. The accumulation of large inventories is costly to the Government and reduces the quantity available for domestic use and exports during the accumulation. The larger buffer stock does provide price stability, as shown by the low value of the coefficient of variation on price (.09). It also allows greater variation in the quantity exported.

These results show that program goals may be thwarted with improperly specified price bounds. Stocks will be depleted if the sale price is set too low. Carrying charges will be too large if purchase price is too high and large quantities of stocks amass.

COMMENTS ON THE MODEL

The wheat market simulator can be useful for policy analysis—especially for questions about price and income stability where deviations of production and use from the mean, rather than the value of the mean, are the main interests. As shown in these results, the mean can be misleading—for example, Treasury costs could have an expected value near zero, but there could be a small probability of intolerable Treasury costs. These distributional data are very important.

The model is easy and cheap to use. It is especially designed so that parameters can easily be changed. The parameters and functional forms of the supply and demand equations, for example, can be changed and the model rerun in 1 day. Also, it maximizes use of economic theory and has relatively small data requirements vis-a-vis a mathematical programming model.

The most important variable in the model, and the one hardest to estimate econometrically, is the price elasticity of export demand. An elasticity of -1.0 was used. Greater elasticity (say, -5.0) would increase price stability and lower the expected volume of buffer stock purchases and sales. A lower elasticity would be associated with greater variability and a need for a larger volume of stocks.

The effect of price variance on the shortrun supply function and on the export demand function is not accounted for in the model. These relationships need further research and could cause major modification in the results. Production theory suggests that the shortrun supply function shifts to the right as price variability is reduced. Also, some foreign trade experts think that a reduction in price variability in the United States (in essence, increasing the chance that the United States will have adequate amounts to export at reasonable prices) will increase export demand.

Further research with the wheat simulation model is needed to explore alternative storage rules with self-correcting mechanisms. One promising rule is to define the purchase and sale prices as functions of the size of the buffer stock currently on hand. As the buffer stock increases beyond limit, the purchase and sale price could be lowered and vice versa. In this manner, a target level of stocks could be approached over time, buffer stock program goals would more likely be achieved, and extreme Government costs could be avoided.

Further research with the wheat market simulator will include:

(a) defining purchase and sale prices as a function of the size of the buffer stock,
(b) partitioning the export demand function to account for the price responsive and price non-responsive foreign buyers, and
(c) putting an upper limit on Government spending.

REFERENCES

(1) Barr, Terry N.
"Demand and Price Relationships for U.S. Wheat Economy", *Wheat Situation*, Econ. Res. Serv., U.S. Dept. of Agr. WS-266, Nov. 1973.

(2) Breimyer, Harold F.
Alternative Approaches to Stabilization Problems, Dept. of Agr. Econ. Paper No. 1974-36, Univ. of Missouri, Columbia, Mo., Sept. 1974.

(3) Garst, Gail D. and Thomas A. Miller
"Impact of the Set-Aside Program on U.S. Wheat acreages," *Agr. Econ. Res.*, 27:2, Apr. 1975.

(4) Hoffman, Robert G.
"Wheat: Regional Supply Analysis," *Wheat Situation*, Econ. Res. Serv., U.S. Dept. of Agr., WS-225, Aug. 1973.

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(5) Johnson, D. Gale
"World Agriculture, Commodity Policy and Price Variability," Univ. of Chicago, Office of Agr. Econ., Res. Paper No. 75:20, Aug. 8, 1975.

(6) Mayer, Leo V.
"Grain Stockpiles and Commodity Reserves," Report of the Subcommittee on Domestic Marketing and Consumer Relations of the Committee on Agriculture, 94th Cong., 1975, Congressional Research Service, Library of Congress, June 1975.

(7) Ray, Daryll E., James W. Richardson, and Glenn S. Collins
"A Simulation Analysis of a Reserve Stock Management Policy for Feed Grains and Wheat," contributed paper at Southern Agr. Econ. Assoc. Annual Meetings, New Orleans, Feb. 1975.

(8) Sharples, Jerry A. and Rudie W. Slaughter, Jr.
"Producer Price and Income Stabilization: Concepts, Means, Program, and Research Implications," speech presented to Policy Research Workshop sponsored by North Central Public Policy Research Task Force and others, Washington, D.C., Jan. 15-16, 1976.

(9) Tweeten, Luther G.
"The Demand for United States Farm Output," *Food Research Institute Studies*, Vol. VII, No. 3, 1967, pp. 343-369.

(10) Tweeten, Luther, Dale Kalbfleisch, and Y. C. Lu
An Economic Analysis of Carryover Policies for the United States Wheat Industry, Agr. Exp. Sta., Tech. Bul. P-132, Oklahoma State Univ. Oct. 1971.

(11) United Nations, Food and Agriculture Organization
"Food Reserve Policies for World Food Security: A Consultant Study on Alternative Approaches," ESC:CSP/75/2, Jan. 1975.

(12) Walker, Rodney L. and Jerry A. Sharples
Reserve Stocks of Grain: A Review of Research, Econ. Res. Serv., U.S. Dept. of Agr., Agr. Econ. Rpt. No. 304, Aug. 1975.