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ANNE E. PECK*

IMPLICATIONS OF PRIVATE STORAGE OF GRAINS FOR BUFFER STOCK SCHEMES TO STABILIZE PRICES†

Proposals for publicly controlled or sponsored reserves of grains, to be accumulated during times of plenty and released during times of shortages, appear to provide sensible means toward reducing instability of prices and supplies. Yet recent theoretical work—for example, Turnovsky (*12*) and Just et al. (*6*)—has shown that the distribution of gains and losses among consumers, producers, and the rest of society is quite sensitive to the economic characteristics of the specific grain market. Moreover, Gustafson (*4*) and Helmberger and Weaver (*5*) have shown that the activities of the private, commercial storage sector have a marked effect upon the expected social outcomes. They argue, in fact, that if commercial storage is profit maximizing, it will also be socially optimal and additional storage would entail net losses to society.

The role and performance of private storage needs to be understood as a prerequisite to evaluation of any proposed public role. This paper summarizes the historical role of private storage of wheat in the United States. Analysis of the Commodity Credit Corporation's (CCC) wheat-storage operations provides evidence regarding their impact upon commercial storage incentives. Even though CCC operations were viewed as "surplus" operations, their impact on private storage was probably little different than they would have been if the objective had been management of reserves. Finally, the paper employs simulation analyses to contrast more clearly models incorporating private storage and those which omit it.

THE EXTENT OF COMMERCIAL DEMAND FOR WHEAT FOR STORAGE[1]

In a series of papers, Holbrook Working established the importance of privately held stocks in the wheat market and the role that futures markets play in

*The author is Assistant Professor, Food Research Institute.

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[1] The material in this section relies on the analyses in Peck and Gray (*9*). A more detailed discussion both of the role of commercial stocks and of the demand for wheat for storage is available there.

guiding these stocks-holding decisions (*15*, *17*, and *18*). Commercially held stocks of wheat were found to be at least as important as exports in absorbing the year-to-year fluctuations in domestic production over the period 1898-1932 (*15*). Data from a more recent period confirms the importance of fluctuations in privately held stocks when government controls are not the dominant price-determining factors. The carryout from the 1973-74 crop year was 340 million bushels, virtually all held in private hands. By the end of 1975-76, the carryout nearly doubled at 664 million bushels, most of which was also privately held. The following year, the carryout climbed to 1,105 million bushels, although a portion of this was held under government loan and reseal programs announced in the spring of 1977. Carryout stocks change dramatically with changes in market conditions and these changes are comparable in magnitudes with the changes in annual domestic use and annual export use.

Given both the size and the extent of fluctuations in commercially held wheat stocks, models of the wheat market which exclude this demand component seriously misrepresent the operation and implications of the "free" market. The central question is how to include a commercial demand for storable wheat into such formulations. Previous models have assumed either that year-end stocks do not vary or that stocks are held in response to the current price relative to some notion of an expected price. The former assumption is equivalent to ignoring commercial stocks. The latter approach raises the difficulty of quantifying an expected price, made greater here because an expectation for next year is clearly dependent upon what happens this year as well as on expectations for all the endogeneous variables over an infinite time horizon.

The most common resolution of this problem has been to employ some variant of the rational expectations hypothesis. For example, Meinken used an indications variable, fall plantings of winter wheat for harvest the following year, as a proxy for market expectations of price (7). Vannerson employed a similar substitution in his annual models (*14*). To facilitate estimation, these relationships have been viewed typically as linear. But, as Helmberger and Weaver have shown in their recent theoretic analysis, even the rational expectations hypothesis leads to a strongly nonlinear demand for grain for storage (5).

However innovative, these approaches ignore the institutional setting in which the decision to store grain between crop years is made. Specifically, attention has not been focused on the role that futures markets perform in providing market-determined prices of storage to guide inventory decisions. These markets also provide a mechanism whereby the returns to storage can be predicted reasonably accurately when the storage decision is made.

Empirical analysis of this role led Working to posit his theory of the price of storage, which relates the difference in prices for futures contracts of differing maturities to stocks of the commodity to be stored.[2] The relationship he found, now commonly called a supply of storage curve, is strongly kinked. At low levels of stocks, a positively sloped portion of the curve reveals that stocks are quite sensitive to the price of storage. As stocks increase, however, the market-determined price of storage approximates the total cost of storage, and the

[2] The original investigations of these relationships are in Working (*17*). In (*16*) and (*18*), he summarizes the theoretical importance of the relationship and develops the important role hedging plays in its determination.

relationship becomes nearly horizontal. Over a wide range of stock levels, no further increases in the price of storage are required to induce increases in the amount of the commodity that is stored. Recently, Peck and Gray argued that this supply of storage relationship also describes a demand by the commercial trade for the commodity to be put into storage (9). In supplying storage space, commercial firms demand specific commodities at various times to put into storage. To produce an output of stored commodity, firms must demand the commodity in competition with other users to put into storage. Thus, Working's evidence would suggest that the demand for a commodity to put into storage is also strongly kinked.

Chart 1, reproduced from (9), is one attempt to translate this demand for a commodity to put into storage into the context of an annual commodity model with specific reference to the wheat market. As with the supply of storage curve, it is strongly nonlinear. This curve, however, has no strictly horizontal component; there is no maximal, cost-of-storage difference between the current year's annual price and the notion of normal price, the mean, which is used here. This "price of storage" is not one that can be earned in the market. Further, the relationship in Chart 1 reflects the complex interaction of consumption demand (export and domestic) and storage demand. In a complete model, these demand curves should be estimated simultaneously. The point here, however, is simply to establish a reasonable shape for the storage function. The horizontal component of the traditional supply of storage curve reflects the fact that traders are willing to store any amount of grain at full carrying charges. Viewed as either horizontal or gradually decreasing, this component of the storage curve implies that total demand becomes much more responsive at low prices than at higher prices. That is, total demand is indeed segmented, the kink a result of private stocks-holding.

SHIFTS IN THE DEMAND FOR STORAGE

A demand for storage curve similar to that shown in Chart 1 was used in the market simulation to be discussed below. The relationship shown in Chart 1, however, relied on somewhat dated historical evidence which raises two concerns. The first is whether there has been a shift in the curve over time due to industry growth. The carryout of wheat from the 1973-74 crop year totaled 247.4 million bushels, virtually all in private hands.[3] The difference between the July and the May futures (the price of storage) on April 15, 1974 was -23 cents. The following year's carryout was 326 million bushels with a price of storage of -8 cents. These observations would not fit either the 1892-1933 relationships developed by Working or the curve shown in Chart 1. They reflect the changes in milling and export capacity which have increased the level of desired, working stocks. To account for this difference, the demand for storage used in the simulations was shifted to the right of the curve shown in Chart 1. The exact specification of the storage demand used in the simulation model is shown in Chart 2 and will be discussed below.

A second source of concern relates to the possible effects of government

[3] The analysis and text descriptions in the remainder of the paper utilize carryout data from the old July 1 to June 30 crop year so as to provide a consistent set of observations over the entire 25-year period.

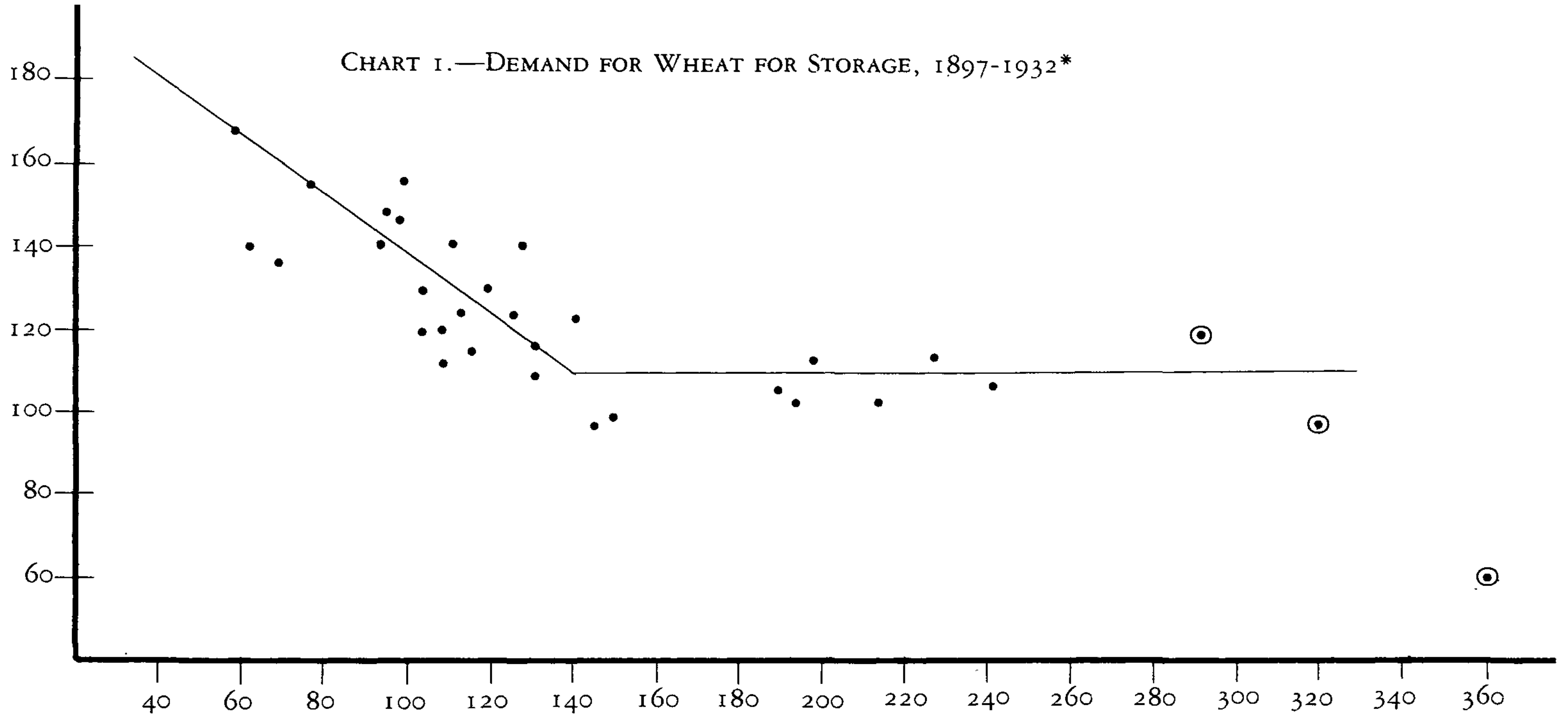


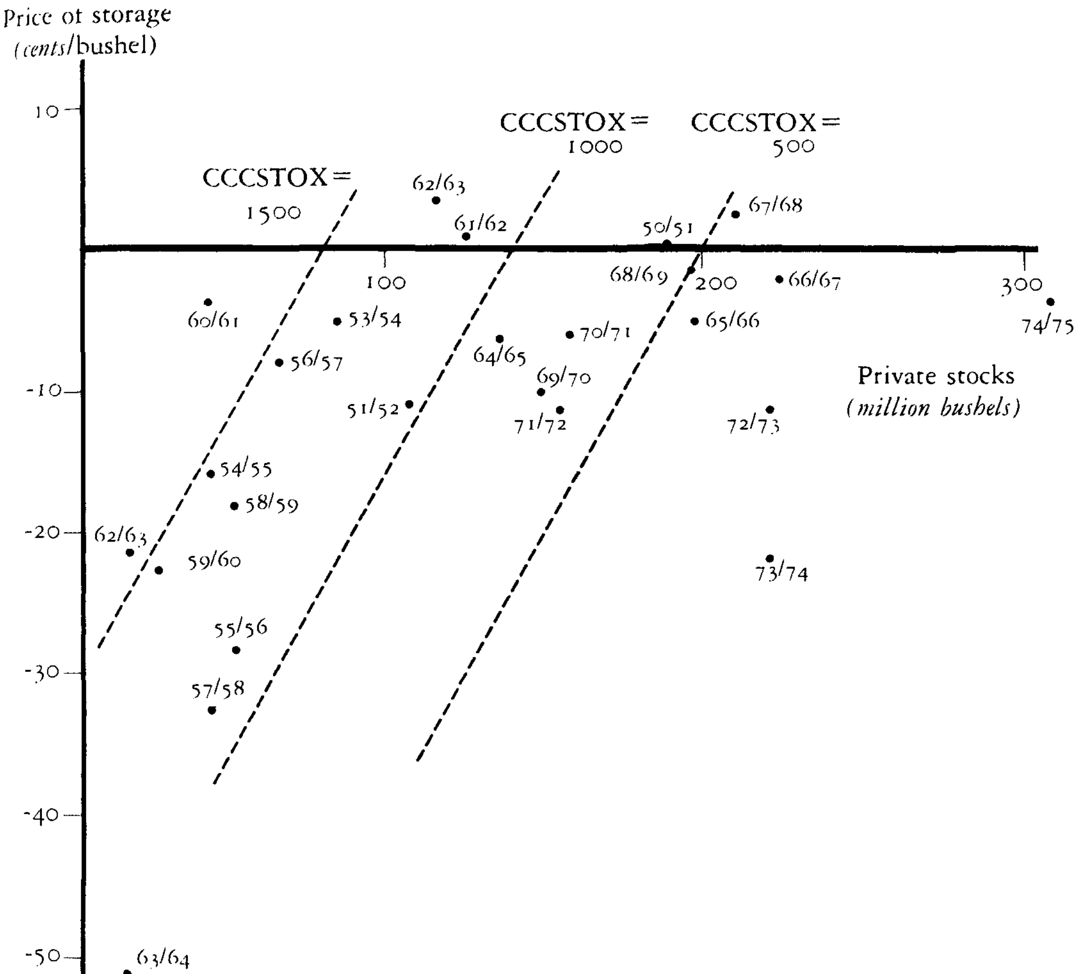
CHART 1.—DEMAND FOR WHEAT FOR STORAGE, 1897-1932*

*The price data are from U.S. Department of Agriculture, *Agricultural Statistics*, Washington, D.C., 1941 and the stocks data are from Holbrook Working, "Price Relations between July and September Wheat Futures at Chicago Since 1885," *Wheat Studies*, 9, 6, March 1933, Appendix Table VI. The prices are deflated by the WPI (1926=100). The observations for 1916/17-1920/21 are omitted due to shifts in demand created by World War I. The circled observations were deleted from the statistical analysis; they are the years 1930-32 when substantial amounts of total carryout stocks were held by the Federal Farm Board. The relationship shown above, estimated using a constrained linear estimation technique is

$$Y = 1.93 - 0.0061X + .0060\ [(X-139.7)D] \qquad R^2 = 0.6454$$
$$(16.7) \quad (-5.9) \quad (3.6)$$

where Y is the deflated price, X is carryout, and D is a binary variable which equals 1 if the carryout is greater than 139.7 (the kink-point) and equals zero elsewhere.

CHART 2.—SHIFTS IN THE SUPPLY OF STORAGE RELATIONSHIP CAUSED BY CHANGES IN GOVERNMENT STOCKS LEVELS, 1950-74*



*Private stocks are taken from *Agricultural Statistics*, U.S. Department of Agriculture, Washington, D.C. various years. The price of storage is the difference between the July and the May future noted on April 15 and taken from *Commodity Futures Statistics*. U.S. Department of Agriculture, Commodity Exchange Authority, annual, 1950-72, and Chicago Board of Trade, *Statistical Annual*, 1973-75.

stocks-holding on the private demand for storage. It seems unlikely that commercial stocks-holders, given otherwise equal incentives, would be willing to carry equal stocks, if in one case the government was holding large stocks while in the other it was not. This argument is most clearly seen in the context of the traditional supply of storage curves. They have been developed as the sum of three marginal cost elements: the physical cost of storage, interest cost on the grain in store, and the marginal convenience attributed to those stocks.[4] The latter factor dominates the storage curve at low levels of stocks and creates the positively sloping portion of the curve. As available supplies become small, the marginal value of owning some of that total supply increases because of the flexibility it provides to the firm in its continuous merchandising and processing decisions. Thus, the storage curve may shift with changes in government-held stocks because these influence the convenience yield of stocks held by private firms. The more abundant are supplies in an accessible position, even if held by the government, the lower will be the value an individual producer or merchant will place on having stocks in his own elevators. Hence government-held stocks may substitute for stocks which would have been held by commercial firms. Analogously, the demand for wheat for storage may shift with changes in government stocks levels.

For purposes of the eventual simulation, the preferred analysis would have been to look at the demand for storage curve, as in Chart 1, and to examine its shifts with government-stocks levels during the 1950-74 period. However, the loan and price support program underwent several substantial changes during this period, changes which probably affected the prevailing view of "normal" price. Furthermore, the obvious simultaneities among price, use, private stocks, and government stocks suggested that the analysis at least ought to begin with more familiar notions of storage response. Therefore data were collected to analyze the more traditional supply of storage curve over this period. These results were then extrapolated to the relationship describing the demand for wheat to put into storage.

In Chart 2 privately held, year-end stocks were plotted against the price of storage, here the difference between the July and the May futures on April 15. The price of storage was positive on only three occasions over the period 1950-74. Further, it appears unlikely that any of these prices represented full carrying costs.[5] Hence, only the positively sloped portion of the supply of storage curve is of importance. Equivalently, these data relate only to the negatively sloped portion of the demand curve in Chart 1. On the further assumption that this portion of the supply of storage curve is approximately linear, it can be estimated with usual regression techniques. The dependent variable was taken to be the

[4] See Brennan (*1*) for a more complete description of the elements important in the storage relationship. An additional factor often included in these discussions is the risk premium. Empirical evidence is divided on this question, although the evidence does not suggest that it exists in the simple ways it has been described.

[5] Warehouses were paid 19 cents per bushel per year, or roughly 1½ cents per bushel per month to store grain under the provisions of the "loan" program. Thus full carrying charges between the May and the July future would be 3 cents a bushel. Only the April 1953 spread, which was 3 cents, represented full carrying charges and perhaps should be deleted in the econometric analysis.

level of privately held stocks at year-end to facilitate later analyses. The ordinary least squares estimates of these data revealed evidence of strong serial correlation among the errors. Therefore, the equation was re-estimated with a corrective procedure.[6] The results are as follows:

$$\text{STOX} = \underset{(34.7)}{257.0} + \underset{(0.46)}{2.51}\,P - \underset{(0.03)}{0.12}\ \text{CCCSTOX}$$

$$R^2 = 0.8653 \quad \text{D.W.} = 1.99$$

where STOX is the level of privately held, year-end stocks of wheat, P is the price of storage (July minus May future on April 15), and CCCSTOX is the level of government-controlled stocks at year's end. The figures in parentheses are the estimated standard errors of the coefficients. These results indicate clearly the influence of CCC stocks on the trade's willingness to carry year-end stocks. The dashed lines in Chart 2, drift lines obtained from the regression results, show the supply of storage relationship for varying levels of government stocks. The larger the level of government stocks, the smaller will be the level of stocks carried by the private firms, given equal price incentives. In the simulation analyses which follow, these results for the supply of storage curve are incorporated into the behavior of the demand relationship for private storage of wheat.

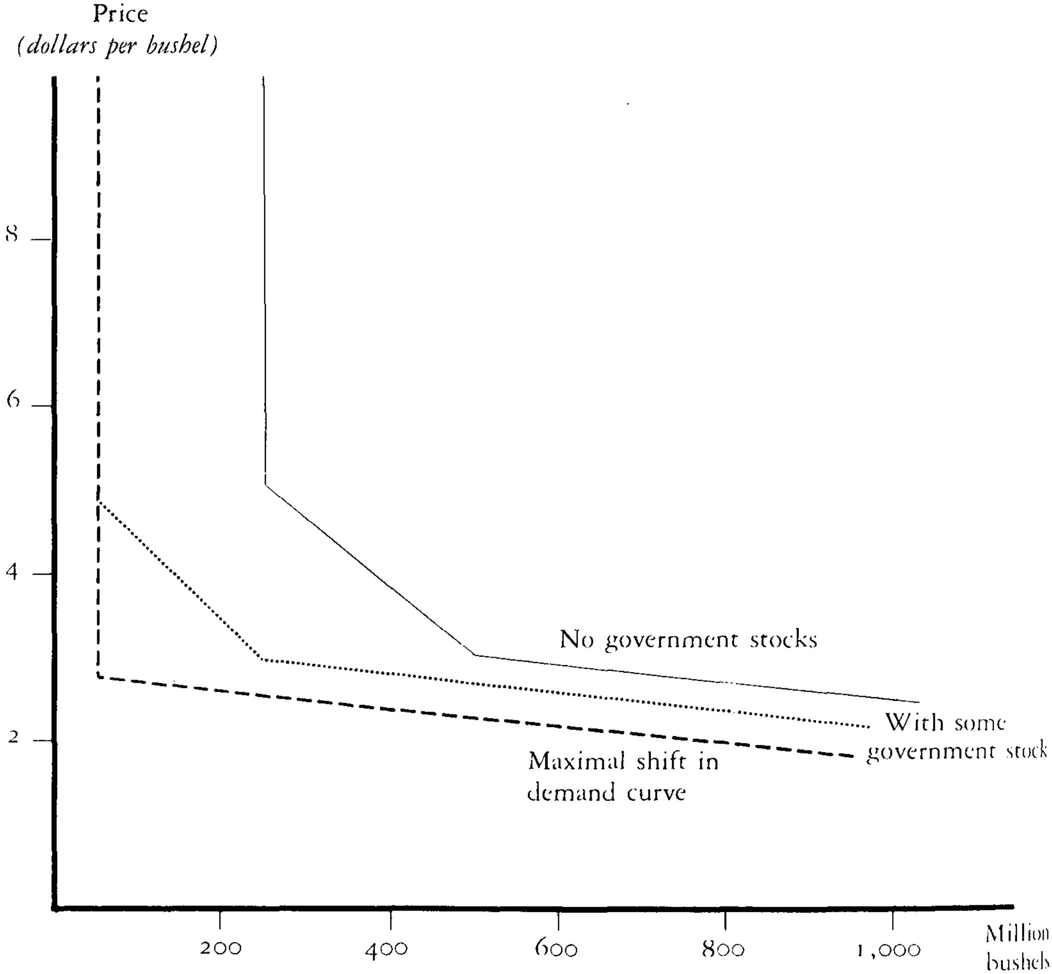
SIMULATIONS OF THE WHEAT MARKET

To permit a comparative analysis, two models of a wheat market are simulated. The first contains no private storage demand. Private stocks are fixed at 300 million bushels, though the specific level is immaterial. The second model of the wheat market contains a demand for storage curve based on the analyses in the preceding two sections. All other relationships in the market models are identical. Included on the demand side are an export-demand equation and a domestic-demand equation with price elasticities approximating -1.0 and -0.2, respectively. A random shifter is assumed to operate on the export-demand curve. Production is the product of acres harvested, determined from a cobweb-type supply function, and a normally distributed yield function. Then, with production determined and the value of the random shifter on the export equation selected, the three demand equations are solved simultaneously to provide a price.[7]

[6] A Cochrane-Orcutt iterative procedure was used. The probable source of the significant serial correlation is the omission, in this analysis, of a variable to reflect changing interest rates over the period. Since the supply of storage curve estimated here was not to be used directly in the simulation analyses, this possibility was not investigated further.

[7] A more complete description of the basic simulation model used here is available in Sharples, Walker, and Slaughter (*11*). The specific model made available for this research had undergone substantial changes from the model described there. Most of the changes were eliminated in this analysis to facilitate the comparison. They dealt with acreage set-aside, deficiency payments, and target prices.

CHART 3.—THE DEMAND FOR STORAGE: FORMULATIONS USED IN THE SIMULATION ANALYSES



The demand curve for wheat for storage in the simulation model is formulated as

$$\text{STOX} = \text{P} \begin{cases} 3{,}400 - 1{,}000\,\text{P} - 0.1\,\text{CCCSTOX}: & 0 < \text{P} \leq 2.90 \\ 814 - 108\,\text{P} - 0.1\,\text{CCCSTOX}: & 2.90 < \text{P} \leq \text{P}^*, \end{cases}$$

where STOX and CCCSTOX are as before, and P is now the annual average price. Additionally, private stock levels are not permitted to decrease below 250 million bushels if there are no government stocks, or below 50 million bushels if there are government stocks. That is, the curve becomes vertical at some P*, where P* varies with the level of government stocks. The basic curve is shown in Chart 3 along with two shifts occasioned by increasing levels of government stocks.

The curve was positioned so that pipeline stocks (stocks carried in the absence of any price incentive) are between 400 and 500 million bushels. The main kink in the curve was put at \$2.90, roughly the full cost of storage (\$0.40) below the equilibrium price of \$3.30. With no government stocks, private stocks cannot drop below 250 million bushels and the curve becomes vertical at \$5.22. An example of the demand for storage shifted by government stocks is shown by the dotted line. Finally, the maximum shift in the storage curve is shown with a dashed line. At some level of government stocks (a level determined by the rate of shift of the curve), the demand for storage by private traders will shift no further. Private stocks will never be negative and, at prices below \$2.90, the incentive to store remains. The latter implies that the long-run average price remains unchanged with a government program in effect.

There is one important difference in this formulation of the demand for storage relative to the historical analyses above. The analysis of the traditional supply of storage curve over the 1950-74 period revealed that there were no years in which the price of storage, the difference between the futures prices for the old and new crop contracts, equalled the full, physical costs of storage. This formulation of the demand for storage for the simulation model clearly permits the equivalent of full carrying charges to occur. At prices of \$2.90 and below, the private demand for storage is once again completely responsive to storage incentives, regardless of the level of government stocks. The model and the historical evidence are not completely reconciled, which is perhaps due to the simplified, partial nature of the preceding analyses. For example, the possible effect of using loans rather than direct purchase has not been explored. A loan program is not equivalent in its market effects to a government-stocks agency buying and selling at predetermined prices.[8] Another likely cause of this difference is that loan prices were never set at more than the full cost of storing wheat below the equilibrium price. Whichever is the more important cause, this difference between the model and the evidence should be held in mind as the simulation results are presented.

Comparative characteristics of the two specifications of the wheat market, with and without a storage demand curve, are summarized by the results in Table 1 and Chart 4. In Table 1, the annual averages and standard deviations of several important variables are presented. These results are based on identical runs of 500 seven-year sequences. In terms of levels of production, exports, and domestic use, the two models performed similarly. The most striking differences between the two models are in the carryout level and the price level. The first difference was foreordained. In the first model the behavior of the other variables would not change if pipeline stocks were set at any other level. Their constancy from year to year implies that they have no effect upon prices or upon any of the uses. The second difference, that between the average prices, will be explored further. It is worth noting that the intersection of the supply and the total demand curve in each model is the same. Hence, the reported differences in means derives from the distribution of prices in each model and hence from the nonlinearities in the respective total demand curves.

[8] For example, Gray has shown that the operation of the loan program induced a bias in the price of the December wheat future (3). While this bias does not affect the analysis here directly, it is suggestive of the kinds of effects potentially created by the specific operation of a loan program.

TABLE 1.—COMPARISON OF KEY CHARACTERISTICS OF THE TWO MODELS OF THE WHEAT MARKET*
(millions of bushels unless otherwise stated)

Item	Model with no demand for storage: Mean	Model with no demand for storage: Standard deviation	Model with demand for storage: Mean	Model with demand for storage: Standard deviation
Production	2,177.3	452.1	2,118.6	256.2
Price *(dollars per bushel)*	3.58	1.71	3.32	0.85
Domestic use	902.1	78.3	889.8	30.3
Exports	1,275.0	394.1	1,207.4	220.0
Private stocks	300.0	0.0	545.8	197.2

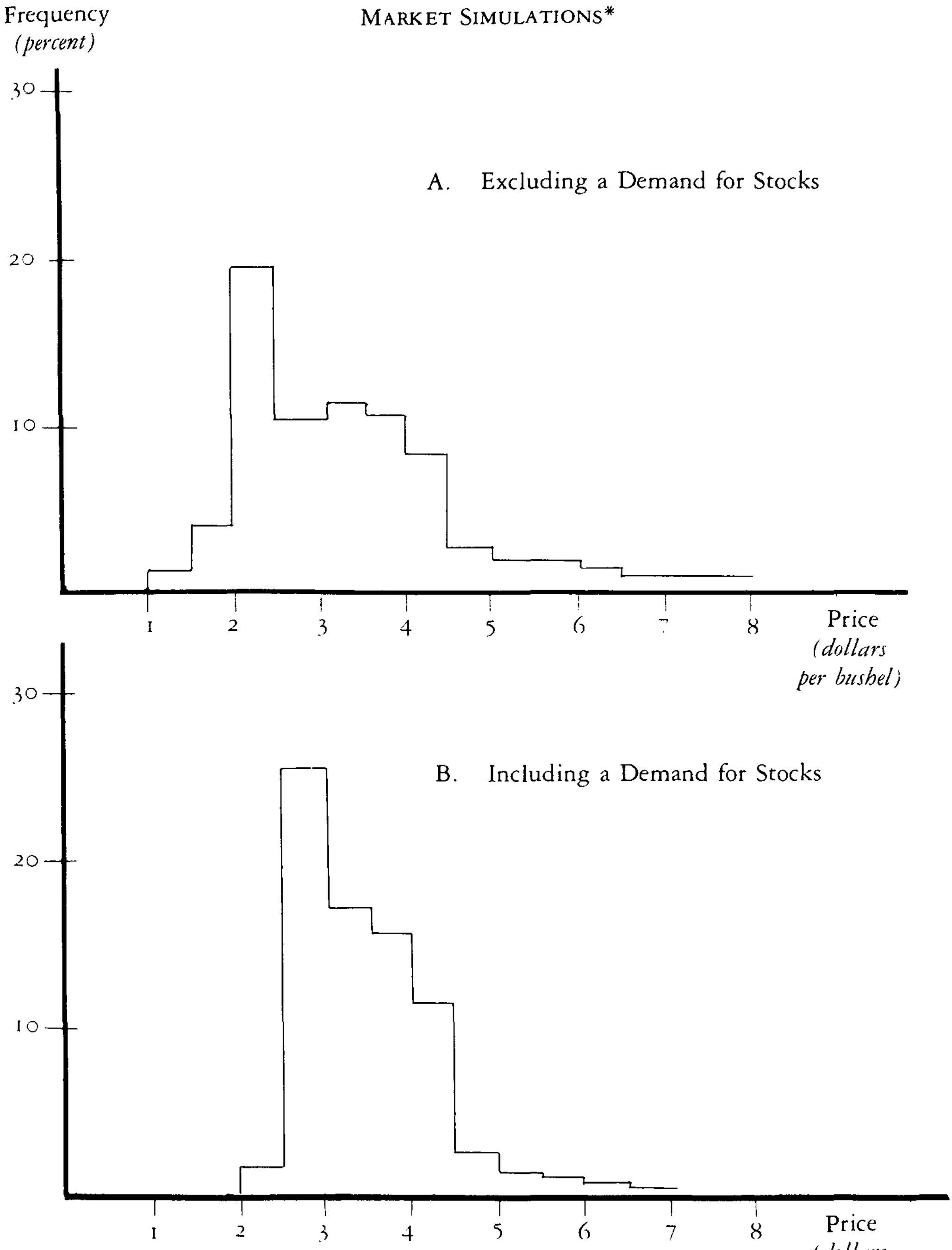
*Simulation results with 3,500 observations (500 seven-year runs).

The other important difference in the results of these two market simulations occurs in the measured variation within each model. The model which includes a demand for storage produces a remarkably more stable market. In particular, price variability was halved by addition of the demand for storage curve. This reduction in variability is then reflected in each of the other series, as their variability depends at least partially upon that of price. The changed behavior of prices is the key difference between these two models.

Chart 4 was prepared to examine more closely the change in price behavior caused by the addition of a storage demand. The top half of the chart depicts the distribution of prices when no storage demand is included in the market model while the lower half shows the distribution of prices when storage demand is included. In the latter, the price distribution is clearly more concentrated. When there is demand for storage, market price did not fall below $2.00. Since all of the very low prices were eliminated, one might expect a higher average price in the second simulation. But, the inclusion of a storage curve also greatly increased the number of prices between $2.50-$3.50 and virtually eliminated prices over $4.50. As a consequence, the reported mean is lower in the second model. However, the difference is not significant. The halving of the price variation, however, has important implications for buffer stock schemes. Private demand for stocks has eliminated both the disastrously low prices and the unacceptably high prices which make buffer stock schemes so intuitively appealing.

To illustrate the effect of private storage, three buffer stock schemes with three different buying and selling prices are investigated. Under the first, the buffer stock agency buys at $1.00 below the equilibrium price of about $3.30 and sells at $1.00 above it. Under the second it buys and sells at $.50 below and above equilibrium and under the third the spread is narrowed to $.25 below and above equilibrium. The only constraints on the agency are that it cannot hold more than 1,000 million bushels and that it cannot sell stocks it does not have. Thus, prices

CHART 4.—DISTRIBUTIONS OF PRICES FROM THE WHEAT MARKET SIMULATIONS*



*Simulation results

TABLE 2.—COMPARISONS OF KEY CHARACTERISTICS OF TWO MODELS OF THE WHEAT MARKET UNDER THREE DIFFERENT STABILIZATION SCHEMES*
(million bushels unless otherwise noted)

	Market without private storage		Market with private storage	
	Annual average	Standard deviation	Annual average	Standard deviation
Price stabilized within $1.00 of the long-run average price				
Production	2,152	376	2,120	255
Price (*cents/bushel*)	346	135	332	84
Private stocks	300	0	544	194
Buffer stocks	197	305	8	54
Government cost (*million dollars*)	121	546	6	71
Price stabilized within $.50 of the long-run average price				
Production	2,133	274	2,128	231
Price (*cents/bushel*)	337	91	335	72
Private stocks	300	0	459	109
Buffer stocks	436	361	330	361
Government cost (*million dollars*)	250	871	196	614
Price stabilized within $.25 of the long-run average price				
Production	2,129	240	2,130	209
Price (*cents/bushel*)	336	76	336	61
Private stocks	300	0	426	98
Buffer stocks	495	365	493	385
Government cost (*million dollars*)	304	1,011	287	892

*Simulation results.

above and below the ceiling and the floor prices are possible. Also, the private demand for storage is presumed to shift to the left as government stocks increase as described above and illustrated in Chart 3.

Table 2 summarizes the effects of the three simulated buffer stock schemes on key market variables under the two different specifications of the wheat market. In the market without private storage, stabilization is costly and difficult to achieve. For example, trying to maintain prices within $.25 of the equilibrium price resulted in annual average expenditures of $304 million and still left the

TABLE 3.—FREQUENCY OF BUFFER STOCK AGENCY ACTIVITIES*
(percent)

Activity or results under specified scheme	Market without private storage		Market with private storage	
	Zero initial stock	300 million bu. initial stock	Zero initial stock	300 million bu. initial stock
Price stabilized within $1.00 of long-run average price				
Purchased	16.4	14.3	0.7	0.3
Sold	9.1	18.1	0.0	8.5
Price below lower bound	2.2	0.9	0.1	0.0
Price above upper bound	13.7	7.2	9.2	3.0
Price stabilized within $.50 of long-run average price				
Purchased	35.8	35.9	24.3	25.2
Sold	23.6	29.3	12.9	22.5
Price below lower bound	9.1	7.7	5.7	4.2
Price above upper bound	13.6	8.4	16.4	9.6
Price stabilized within $.25 of long-run average price				
Purchased	41.4	42.0	35.3	37.7
Sold	30.1	36.0	23.5	31.4
Price below lower bound	13.9	12.5	16.2	12.8
Price above upper bound	15.9	11.1	17.5	14.1

*Simulation results. Figures are percentages, indicating how frequently a specific action (e.g., purchase or sale of stock) or event (price remaining above upper bound price or below lower bound price) occurred. For example, in stabilizing price within $1.00 of the long-run average price, the government was required to purchase wheat 16.4 percent of the time or (roughly one out of every six years) in the absence of a private demand for stocks.

standard deviation of price at $.76. The buffer stock was unable to stabilize prices effectively in part because it had no initial operating stocks. Another simulation was therefore performed which gave the stocks agency initial operating stocks of 300 million bushels. This assumption did reduce substantially the number of times the agency was unable to act because of insufficient stocks as is shown in Table 3. There was no major change, however, in the relative values shown in Table 2.

Perhaps the most interesting feature of these results is the comparative inexpensiveness of each of the proposed schemes when a private demand for stocks has been included, even though the demand for stocks is assumed to shift to the left as government stocks accumulate. The cost of the scheme to stabilize prices between $2.30 and $4.30 would average $121.2 million with no private stocks, but only

$6.0 million with private stocks. The extent of this difference varies with the scheme and the initial buffer stocks assumption, but the difference is always in the same direction.

Costs are not the only concern, of course. It is also important to know how well the scheme performs its primary task of reducing price variability. This too is affected by private demand for stocks. Consider first the situation where no initial stocks are permitted. The most stringent of the price bounds reduced the standard deviation of prices from $1.71 (Table 1) to $0.76, or 56 percent when there were no private stocks. The cost of this reduction averaged $304 million annually. In the model with a private demand for stocks, the reduction in the standard deviation of price was from $0.85 (Table 1) to $0.61, or 28 percent, at an average annual cost of $287 million. When initial government stocks were permitted, the price variation reductions were 66.1 percent and 44.7 percent, respectively, and the costs averaged $286 million and $281 million.

Thus, roughly equivalent expenditure levels ($304 million and $287 million) resulted in markedly different relative reductions in price variability. In the absence of a private demand for storage, price stabilization through buffer stock dealings appears to be reasonably easy to accomplish. However, the most stringent of the proposed price bounds reduces price variation only to a level equal to that found in the "free" market when private storage is permitted. Significant reductions beyond this level were shown to be difficult to obtain. Thus, when the storage sector is included in a market model, much of the intuitive appeal of buffer schemes is eliminated.

The results of the private stocks models raise the fundamental question of how much stability is desired. In the absence of a private demand for storage, expenditures of $250 million to $304 million were required to constrain the variability of prices to a range of $0.91 to $0.76. The variability of prices resulting from the model with a private demand for storage and no government stocks activity ($0.85) is roughly the midpoint of this range. The commercial trade, in its response to storage incentives, thus provides a minimum of $250 million worth of price stability to the market. Is more stability desirable given its increasing costs?

SUMMARY AND CONCLUSION

This paper has sought to examine the implications of private storage of grains for the operation of buffer stock schemes designed to moderate commodity price fluctuations. Simulation techniques were used to compare the behavior of relevant market variables from two models of the wheat market that excluded and included private storage demand. The precise specifications of the models are similar to the kinds of models which are widely used in the examination of buffer stock proposals, except that in the second model the demand by private firms for grain for year-end storage was added to the demands (domestic and export) included in the original specification.

The comparisons here rely solely upon differing assumptions about the nature of private storage of grains. The usual assumption, that private stocks are constant, was compared to one where these stocks are price responsive. The form of the latter relied on historical data. A more complete comparison would entail simulation of two models which had been estimated separately from the same set of historical data. It is unlikely, for example, that the two specifications would result in identical estimates of the elasticities of export and domestic demand. However, that approach, while more nearly complete, would obscure the desired contrast. Differences in the behavior of market variables would be attributable to differing elasticities as well as to differing storage assumptions. Here, differences are clearly the result only of the different storage assumptions.

The comparative simulations showed that private firms contribute on the order of $250 million of price stabilization through their profit-motivated, year-end storage decisions. Thus, these results comfirm the importance of the commercial firms in providing price stability to the grain markets. This importance was originally recognized in the context of futures markets and in the analyses of the economic effect of futures trading. In fact, the form of the demand curve for wheat storage was derived directly from relationships developed in futures market analyses.

The market simulations also demonstrated that the appeal of buffer stock schemes was largely illusory when private firms' behavior was included as a market factor. The remaining price fluctuations were shown to be increasingly difficult to reduce. In part, this was due to shifts in the demand for storage curve induced by government storage. Primarily, however, the increasing difficulty appeared to be the result of the relatively narrow range of price variations which remained after private firms had made their storage decisions. Rather large buffer stock expenditures (average annual cost of $287 million) were shown to reduce price variability by only 27 percent with a significant (17.5 percent) failure rate in preventing high prices.

Once private storage has been accounted for, active buffer stock schemes lose much of their appeal. The remaining variation, as described by the distribution of prices shown in the paper, more nearly supports the grain reserves/stocks fund approaches to stabilization which are designed as insurance schemes, not stabilization schemes. Further analyses of the wheat market as well as other grain markets are required to establish the requisite size of an insurance reserve. The analyses in this paper show that when most needed, the buffer stock schemes do not have the stocks to act.

CITATIONS

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