RETURNS TO ON-FARM STORAGE OF WINTER WHEAT IN MONTANA

Al S. Brogan*

Each year, at harvest, wheat farmers face many marketing decisions. Such questions as where should the crop be sold, and what mode of transportation should be used must be answered. However, each of these questions presumes an answer to a more basic question: should the crop be sold immediately, or should the crop be stored for later sale.

This paper is an attempt to answer that basic question. The scope is limited to a single crop, winter wheat, and to a specific geographic area, the State of Montana. In the first section the theory of the price of storage and of the storage supply curve is examined. The second section develops the methods used in determining monthly price changes. In the third section the percent price changes are calculated for one month intervals. In the final section conclusions are drawn, and the validity and applicability of the results are discussed.

The Theory of Storage

The theory of storage of commodities which has developed is in part a reflection of the nature of agribusiness. Storage has traditionally been supplied by producers, merchandisers, and processors of grain. Microeconomic theory suggests that storage will be supplied to that point at which marginal revenue is equal to marginal cost.

---

*Al S. Brogan is a senior in Agricultural Business, Montana State University.

Paper presented at aaea annual meeting, Columbus, Ohio, Aug 10-13, 1975.

The cost of storage consists of three components: the outlay for physical storage facilities, a risk premium, and a convenience yield.[1] The outlay for physical storage facilities consists of rent for the storage bin, charges for handling the grain, interest on the money tied up in the grain, and insurance premiums for protection against damage to the grain. The risk premium is a charge which is made to compensate for the possibility of loss which is associated with ownership of a commodity.[2] The convenience yield is the benefits which accrue to having stocks on hand to maintain a constant level of plant operation or to provide regular customers with a steady flow of goods.[3] This may be expressed as follows:

$$C = P + R - Y$$

where C is the cost of storage,

P is the outlay for physical storage facilities,

R is the risk premium, and

Y is the convenience yield.

Marginal cost will than equal C' and $C' = P' + R' - Y'$.[4] Each of the terms of the equation can be examined individually.

---

[1] Brennan, Michael J., "The Supply of Storage", American Economic Review, Vol. XLVIII, p. 53.

[2] Brigham, Eugene F. and James L. Pappas, Managerial Economics, The Dryden Press, Hinsdale, Illinois, 1972, p. 56.

[3] Kaldor, Nicholas, "Speculation and Economic Stability", Review of Economic Studies, Vol. VII, p. 6.

[4] Differentiating C with respect to quantity gives the marginal cost, C'. This is equal to the sum of the derivatives of P, R, and -Y.

The marginal outlay for physical storage facilities, while varying among firms, will, for the entire industry, be fairly constant until the capacity of existing storage facilities is reached. Beyond this quantity of capacity, P' will become an increasing function. The cause of this behavior is the additional cost associated with increasing investment in storage facilities.

The marginal risk premium will be an increasing function throughout its range. At the point where the quantity of stocks on hand endangers the credit and liquidity positions of the firm the rate of increase of R' will be increasing very rapidly.

The marginal convenience yield will be a decreasing function. When stocks are small the associated convenience will be great. However, as the quantity of stocks increases the additional convenience from incremental quantities will decrease. When the marginal convenience yield reaches zero the stock will be at a point of surplus.

In figure 1 the three components are shown individually and then combined according to the formula to illustrate the marginal cost curve for storage by non-farm suppliers. The marginal cost of storage is negative where the marginal convenience yield is so large as to outweigh the sum of marginal outlay for physical storage facilities and the marginal risk premium.

For the individual farmer, however, the convenience yield is zero at all times. Since the grain farmers does not use the grain as an input there is no convenience to production as a result of having stocks on hand. Furthermore, the nature of the farmer's markets is such that his customers do not expect a steady supply of grain. Since the convenience

Figure 1

Marginal Cost Curves for Non-farm Suppliers of Storage

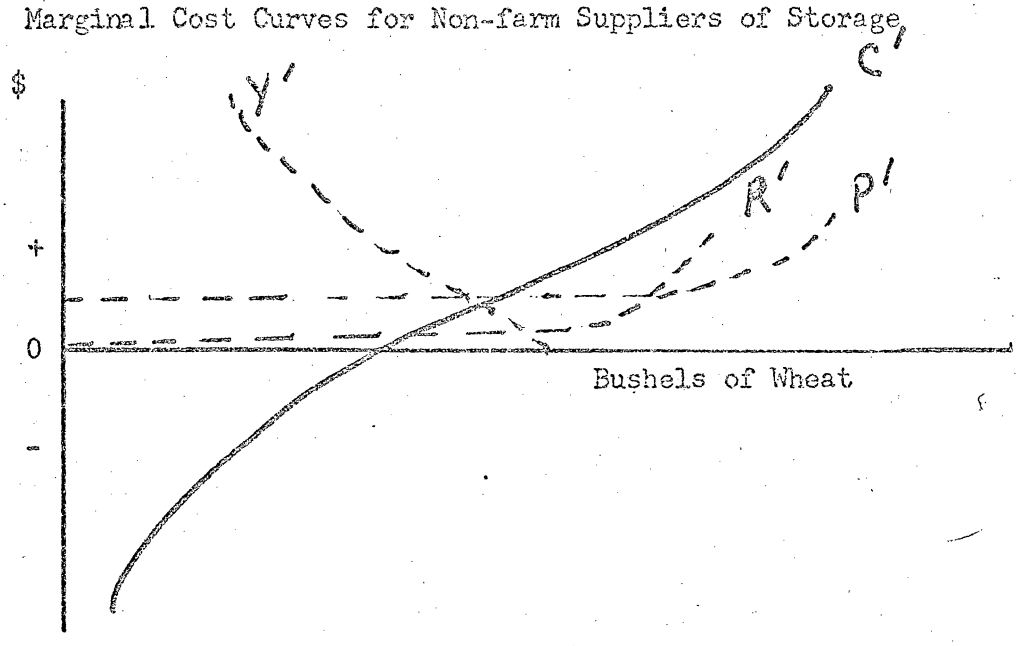
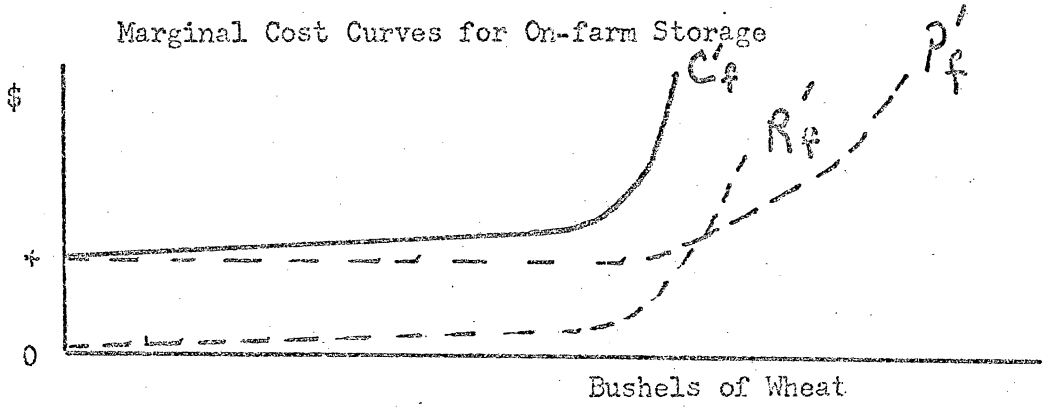


Figure 2

Marginal Cost Curves for On-farm Storage



yield is a constant zero the marginal convenience yield is zero. This results in a marginal cost curve as illustrated in figure 2.

The individual farmer should store grain to that point at which his marginal cost of storage is equal to his marginal revenue from storage. The marginal revenue is the change in price from the initial period to the marketing period.

Methodology

The prices used in this study were average monthly prices received by Montana producers for winter wheat. The analysis covers July 1930 through June 1974. These prices were chosen because winter wheat is the major grain crop in Montana and because average price is representative of what average producers received.

Using these prices, probability distributions of percentage price change for each of eleven intervals between months in a crop year are estimated. Percentage changes are used to facilitate comparison with the opportunity rate of interest.

The percentage change is given by the formula:

$$\Delta WP_{m,i} = \frac{WP_{m+1,i} - WP_{m,i}}{WP_{m,i}}$$

where $WP_{m,i}$ is the price in the m-th month in the i-th year and $WP_{m+1,i}$ is the price in the next month.

The expected value of each probability distribution is determined by the formula:

$$E(\Delta WP_m) = \sum_{i=1}^{n} (\Delta WP_{m,i}) (p_{m,i})$$

where n is the number of years and

$P_{m,i}$ is the probability of a given percentage price change.

An estimate of the variance about the expected value is determined by the formula:

$$s_m^2 = \sum_{i=1}^{n} (\Delta WP_{m,i} - E(\Delta WP_m))^2 \, p_{m,i}$$

Data

The distributions of price changes show expected decreases in prices from July to August, from September to October, from January to February, and from May to June. During the remaining periods, expected increases ranges from a low of 0.7 percent in the period from February to March, to a high of 3.0 percent in the period from August to September, Table 1. The distributions reflect that governmental programs during this period had a stabilizing effect on prices. When prices did fluctuate they moved in a wide range. Table 1 shows the expected value and the standard deviations for each interval. Table 2 shows the cumulative expected percentage return and the equivalent annual rate of return to storage begun in August. The annual rate is calculated by simply dividing the cumulative rate by the proportion of 12 months that the wheat has been stored.

Conclusion

This analysis indicates that there is a positive expected return to storing winter wheat in Montana. The expected cumulative rate of return increases as wheat is stored from August to December. The percentage expected rate of return is maximized by storing until May. Based on this data, it would appear that if a farmer stores past December he

Table 1

Expected Value of Percentage Price Change

Interval	Expected Value	Standard Deviation
July - August	-1.16	.148
August - September	3.05	.083
September - October	.00	.067
October - November	1.82	.067
November - December	2.34	.061
December - January	1.24	.038
January - February	-1.17	.057
February - March	.72	.055
March - April	.86	.064
April - May	.78	.068
May - June	-1.79	.084

Table 2

Expected Return to Winter Wheat Placed in Storage in August

Months Stored Beginning in August	Cumulative Expected Percentage	Annual Expected Rate of Return
1	3.05	36.6
2	3.05	18.3
3	4.86	19.4
4	7.20	21.6
5	8.44	20.3
6	7.27	14.5
7	7.99	13.5
8	8.85	13.3
9	9.63	12.8
10	7.85	9.4

should store until May.

The rate of return shows an increase in the autumn months, followed by a sharp drop in January, then a steady increase until May. A possible cause of this drop in January to February period is tax sales. It is possible that many farmers are storing their crop past the first of the year to take advantage of the tax laws. This hypothesis needs to be tested further.

If a farmer's calculated marginal cost is below the indicated expected return, then he should engage in storage. A caution which must be made, however, is that this analysis is based on data from a period of relatively stable prices. Many of the governmental programs which encouraged this stability no longer exist. The effects of price stability on expected returns to storing winter wheat are speculative, but price instability almost assuredly increases the risk associated with storing wheat.

The scope of this paper was to estimate the return to storing winter wheat in Montana rather than the cost. It may be possible to estimate the outlay for physical storage facilities, but each farmer must decide how much risk he is willing to bear.

BIBLIOGRAPHY

Brennan, Michael J., "The Supply of Storage", American Economic Review, Vol. XLVIII.

Brigham, Eugene F. and James L. Pappas, Managerial Economics, The Dryden Press, Hinsdale, Illinois, 1972.

Kaldor, Nicholas, "Speculation and Economic Stability", Review of Economic Studies, Vol. VII.

Working, Holbrook, "The Theory of Price of Storage", American Economic Review, Vol. XXXIX.