THE POST-HARVEST DEPRESSION OF WHEAT PRICES

INTRODUCTION

The tendency for wheat prices to be depressed in the period immediately following the harvest and to rise subsequently to a higher level in the months preceding the next harvest has been the subject of much discussion. It has frequently been assumed, and often asserted, that the post-harvest depression of prices and the subsequent rise are commonly excessive. The fact that many farmers find it necessary to sell much or all of their crop immediately after harvest has been viewed as one of the major disabilities of the farmer. The theory that wheat prices are unduly depressed immediately after the harvest has played a large part in arguments for additional credit facilities for farmers; in plans for co-operative marketing associations, which have expected to make large gains for the farmer through distributing marketings more evenly through the year; and in proposals for farm relief through the operations of stabilization corporations.

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In much of the discussion of the post-harvest depression of wheat prices and of the plans for modifying the depression or for relieving the farmer of the incident losses alleged, there has been no reference to the facts as observable in the record of prices in past years. When the record of past price movements has been considered, the facts seem frequently to have been chosen for the sake of proving a particular point.

Here and there may be found careful and unbiased attempts to measure the extent of the average rise in wheat prices from the post-harvest period to the period preceding the next harvest.[1] The results of these calculations, however, have not been altogether convincing. There remain wide differences of opinion as to the extent of the post-harvest depression of wheat prices. Many writers and speakers, among them some who are by no means uninformed or irresponsible, continue to feel justified in regarding the post-harvest depression of wheat prices as much more serious than averages for past years indicate. Much doubt remains among serious students as to the real magnitude of the tendency toward post-harvest depression of wheat prices.

It appears worth while, in these circumstances, to assemble the available data and to determine, as accurately as may be possible, the actual magnitude of the tendency to post-harvest depression of prices of the principal classes and grades of wheat in the United States.[2] The principal results of the investigation may be outlined briefly at this point.

What appears on the surface as a simple problem, in principle at least, will be found in fact a complicated problem. The tendency to post-harvest depression of wheat prices is of course obscured in price statistics by price movements arising from

[1] Two studies deserving of special mention in this connection are "The Holding Movement in Agriculture," by J. E. Pope, in *Economic Essays Contributed in Honor of John Bates Clark*, edited by J. H. Hollander (New York, Macmillan, 1927), pp. 244–82; and *Prices of Grain and Grain Futures* (Report of the Federal Trade Commission on the Grain Trade, VI), 1924.

[2] The need for such information has become increasingly apparent in recent months. In two recent numbers of WHEAT STUDIES (June 1929, V, No. 7, and August 1929, V, No. 9), detailed discussions of costs of storage have been given and the cost data compared with average gains from storage, estimated in the usual manner. The present study was originally intended merely to supplement these earlier discussions by bringing forward more complete data on average gains from storage. While it results in estimates of average gross gains from storage considerably higher than those previously accepted, it does not appreciably affect previous conclusions that storage of wheat offers little opportunity for profit. As will be noted from the summary on this and the following page, the more accurate measurement of average gross gains from storage of wheat has become a secondary feature of the present study.

many other causes. It is commonly assumed, however, that the average rise in wheat prices from the immediate post-harvest period to the period preceding the next harvest offers a satisfactory measure of the underlying tendency to post-harvest depression of wheat prices. But for each important class and grade of wheat there is not one constant underlying tendency, but a multiplicity of tendencies, extending over a wide range. No two successive years are characterized by the same underlying tendency, and perhaps no two years among the 22 years which we shall subsequently review show precisely the same tendency. An average of these tendencies is practically worthless, at least for the purpose of judging whether the post-harvest depression of prices is excessive or for judging whether farmers who, because of lack of funds, are prevented from storing wheat through the winter are thereby placed at a disadvantage, since average gross gains from storage may not be assumed to equal the average post-harvest depression of wheat prices. Gains from storage, for certain classes of wheat at least, are readily predictable, so that dealers may keep stocks at a minimum in years that promise no profit from storage and store heavily in those years in which profits promise to be large. Indeed, a moderately good adjustment of stocks to prospective profits from storage is practically forced by circumstances, since the years in which storage is unprofitable are generally the years in which supplies are short and there is little wheat available for storage, whereas the years in which storage is highly profitable are the years in which there is much wheat to be stored.

Perhaps the chief contributions of the present study will appear to be the demonstration of the variability of the post-harvest depression of wheat prices, the discovery of some of the important factors that determine the magnitude of the post-harvest depression, and the proof that the "average" post-harvest depression may not be taken as a measure of average gains from storage of wheat. We have attempted, however, to go further and to throw some light on the question from which the chief interest in the post-harvest depression springs, namely, how large are the average gains from storage of wheat? This question is much more difficult to answer than has commonly been supposed. It is probably quite impossible to arrive at any answer that is at once precise and significant. We are able, however, to assemble data sufficient to prove beyond reasonable doubt that over the period since 1899, omitting the war and immediate post-war years, gains of dealers from storage of wheat were not excessive, and that, over the same period, farmers would not have added greatly to their profits by storing more heavily unless their choice of the years in which to store heavily had been wiser or more fortunate than one might reasonably expect them to have been.

I. CASH WHEAT PRICES

The Data Employed

Probably the best data on cash wheat prices in the United States available for our purposes are the monthly weighted averages compiled by the Bureau of Agricultural Economics of the United States Department of Agriculture covering the period since 1899.[1] The three series for No. 2 Hard Winter wheat at Kansas City, No. 2 Red Winter wheat at St. Louis, and No. 1 Northern Spring wheat at Minneapolis are representative of prices of the most important classes of wheat raised in the United States at the principal cash markets for those wheats.

The average post-harvest depression of wheat prices is best studied as a part of the complete average seasonal movement of wheat prices. A useful measure of the seasonal movement of wheat prices may be obtained by the familiar method of taking simple averages, over an extended pe-

[1] We are informed that tables hitherto published designate as weighted averages a portion of the series for No. 1 Northern Spring wheat (1899–1909), for which the data are actually simple averages of daily prices. (Letter from Dr. O. C. Stine, dated June 21, 1929.)

riod of years, of July prices, August prices, etc. Some modifications of this simple method are, however, necessary. Since our object is to arrive at a measure of the price movement to be expected under ordinary conditions, it is well to omit from the calculations the data for the period 1914–21, during much of which quite extraordinary factors were in operation. It is desirable also to make adjustment for changes in the general wholesale price level. During the period 1899–1914 the drift of prices in general was upward, and the general price level was substantially higher in the post-war years than in the years immediately preceding the war. The generally higher prices of years in which the general wholesale price level was high, as in the post-war years, influence disproportionately the final figures when a simple average of actual prices is taken.

The averages[1] shown in the accompanying tables and charts are based on data for the period July 1899 to July 1928, omitting the war and immediate post-war years, August 1914 to June 1921. The original prices have been adjusted before averaging by dividing each monthly price from July to July by the average wholesale price index number for the corresponding July–June crop year. Since the index number employed is on the base 1913 = 100, the adjusted price averages are in terms of cents per bushel at the 1913 price level. If the general wholesale price level throughout the period had been similar to that obtaining since 1921, the original price data might have been averaged without adjustment, and all the figures would presumably have been about 50 per cent larger than those shown in the tables.

Average Seasonal Changes

Table 1 and Chart 1 (p. 4) show for each month from July of one crop year to July of the next crop year average prices of No. 2 Hard Winter wheat at Kansas City, No. 2 Red Winter wheat at St. Louis, and No. 1 Northern Spring wheat at Minneapolis, in cents per bushel at the 1913 price level, calculated as described above. During the period 1899–1914 there was a general upward drift of wheat prices closely paralleling the upward drift in the general wholesale price index number. It is to be expected that in consequence of this upward drift the averages should show an increase in price from July to the next July.[2]

TABLE 1. — TWENTY-TWO-YEAR AVERAGES OF MONTHLY PRICES OF THREE PRINCIPAL CLASSES OF CASH WHEAT AT UNITED STATES MARKETS, JULY TO JULY*

(Cents per bushel at 1913 price level)

Month	No. 2 Hard Winter (Kansas City)	No. 2 Red Winter (St. Louis)	No. 1 Northern Spring (Minneapolis)
July	88.8	92.7	103.1
Aug.	88.0	92.8	99.0
Sept.	89.2	96.4	96.2
Oct.	90.9	99.4	96.6
Nov.	90.5	98.2	95.1
Dec.	92.1	101.3	97.3
Jan.	94.6	104.9	100.0
Feb.	94.9	105.3	100.7
Mar.	94.6	104.3	99.5
Apr.	94.9	104.7	99.5
May	97.9	106.4	103.4
June	95.8	103.1	102.8
July	89.6	94.3	103.5

* Calculated for the periods July 1899–July 1914 and July 1921–July 1928 from data in *Wheat and Rye Statistics* (U.S. Department of Agriculture Statistical Bulletin 12), January 1926, pp. 79–81; *Agriculture Yearbooks* and *Crops and Markets*, with two corrections, for which see notes to Appendix Tables IV and V. These data represent monthly weighted averages of all cash sales of the grades and at the markets designated, except that for No. 1 Northern Spring wheat over the period 1899–1909 the data are unweighted averages of daily prices (see footnote, p. 2). For this table, simple monthly averages have been taken of the data cited after converting to cents per bushel at the 1913 price level by dividing the price for each month from July to July by the average Bureau of Labor Statistics "all commodities" wholesale price index number for the corresponding July–June crop year, shown in Appendix Table X. This method leaves in the averages any upward trend resulting from the upward trend in the price level between 1899 and 1914.

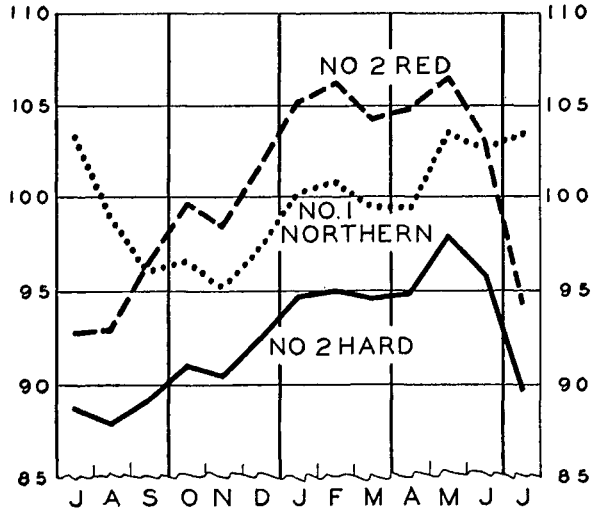
[1] For some purposes and under certain conditions, the arithmetic mean of monthly data, here used, appears to give a less trustworthy measure of seasonal variation than may be obtained by other statistical methods. The principal argument against the arithmetic mean has been that it is unduly affected by extreme values and accordingly gives a less trustworthy indication of the "central tendency." In a study of possible profits from a regular policy of storing wheat from fall to spring, however, interest centers on the long-time tendency of the arithmetic mean price change, and it does not appear that any other average indicates this more reliably than the arithmetic mean itself. In subsequent sections consideration will be given also to possible profits from a policy of storing wheat in selected years rather than regularly.

[2] Had each monthly wheat price been divided by the wholesale price index number for the corresponding month, the effect of the upward drift in wheat prices would have been largely removed, since the trend of wheat prices closely paralleled the trend of

The largest July to July increase, that shown for red winter wheat,[1] is only 1.6 cents, however, while hard winter wheat shows an increase of only 0.8 cent, and northern spring wheat an increase of only 0.4 cent. In these circumstances, little is to be gained by attempting to correct the monthly averages for trend. The wisdom of attempting such a correction is the more doubtful, since it is quite possible that in the absence of an upward trend the figures would have differed from those shown more in exhibiting a greater drop from June to July (for spring wheat a greater drop from July to September) than in any modification of the changes between July and June. Under the circumstances, no correction for trend has been attempted.

CHART 1.—AVERAGE MONTHLY PRICES OF THREE PRINCIPAL CLASSES AND GRADES OF WHEAT IN UNITED STATES MARKETS*

(Cents per bushel at 1913 price level)



* Data from Table 1, p. 3. The markets are: for No. 2 Hard Winter, Kansas City; for No. 2 Red Winter, St. Louis; and for No. 1 Northern Spring wheat, Minneapolis.

The three classes of wheat show very similar price movements from month to month between October and May. The principal difference in these months appears in the stronger upward movement of red winter-wheat prices between November and January and their smaller rise between January and May. The winter wheats show a sharp interseasonal price decline from May to July, while the interseasonal decline in spring-wheat prices occurs chiefly between June and September. Red winter wheat shows a much sharper price decline between June and July than hard winter wheat and a correspondingly greater rise between August and October.

THE POST-HARVEST PRICE DEPRESSIONS

The extent of the average post-harvest depression of wheat prices may be measured either in terms of the drop from the pre-harvest peak to the ensuing post-harvest trough or in terms of the recovery from the post-harvest trough to the subsequent peak. For the winter wheats the peak occurs, on the average, in May. Still higher prices are often recorded in June, but the flow of new wheat frequently beginning late in June lowers the June average below the May average. July may be taken as the month of lowest average prices for winter wheat, although these data show Kansas City prices averaging slightly lower in August. The peak of spring-wheat prices occurs in July; most of the decline in the average takes place between July and September, but a slightly lower level is reached in November, which may be counted the month of greatest post-harvest depression for spring wheat. The following figures for the average post-harvest depression, in cents per bushel at the 1913 price level, are indicated on this basis:

	No. 2 Hard Winter (Kansas City)	No. 2 Red Winter (St. Louis)	No. 1 Northern Spring (Minneapolis)
From pre-harvest peak to post-harvest trough.....	8.3	12.1	8.0
From post-harvest trough to subsequent peak	9.1	13.7	8.4

the wholesale price index number. The method here employed is designed to equalize the weight given each year's price fluctuations in the final series of averages without modifying the trend of the averages.

[1] Here, as at many other points in this study, we omit the grade and market designation for the sake of brevity. The statements apply specifically not to prices generally of the class of wheat designated, but to prices of the particular grade of that class of wheat at the particular market for which the data are used. In each case, however, the market is the most important terminal market in the United States for the particular class of wheat to which the quotations apply, and the grade includes in most years a larger percentage of the crop of that class of wheat than is included in any other grade. The statements, specifically applicable only to a particular grade of wheat at a particular market, may probably be regarded as broadly applicable to all grades of good milling quality within the class, and at most markets.

These measures of the post-harvest depression of wheat prices, showing the average seasonal range of prices, must not be mistaken for measures of the amount of *undue* post-harvest depression. Many discussions appear to use the term "post-harvest depression" to refer solely to an unjustified depression, in addition to the seasonal change reasonably to be expected in view of the cost of carrying wheat in storage from the immediate post-harvest period to the period preceding the new harvest. We know of no way of measuring the *undue* post-harvest depression, except by comparing the total seasonal change with the cost of carrying wheat through the eight or ten months from the period of low prices after one harvest to the period of high prices prior to the next harvest.

Variations among Years

It is a matter of common observation that the rise of winter-wheat prices from July to May is frequently several times as great as the averages shown by these figures. In some years there is a severe decline in prices from July to May. The same may be said of changes in spring-wheat prices from November to July. Indeed, there have been few years in which the actual price movements between the months in question closely approximated the averages. From the detailed data shown in Table 2, or more readily from Chart 2 (p. 6), it will be seen that there were only four years out of the 22 under consideration in which the July–May price change for No. 2 Hard Winter wheat was within 5 cents of the average. For No. 2 Red Winter wheat there were eight years in which the July–May price change was within 5 cents of the average. For No. 1 Northern Spring wheat there were likewise 8 years out of the 22 in which the November–July price change was within 5 cents of the average. These calculations, it must be remembered, are based on prices reduced to the basis of the 1913 price level. A 5-cent deviation from the average, on this basis, is equivalent to a deviation of 7 or 8 cents in actual prices at the general price level prevailing in recent years.

Decreases in the weighted average price of No. 2 Hard Winter wheat at Kansas City between July and May occurred in six years. The greatest decrease—15 cents—occurred in 1910–11. No. 2 Red Winter wheat only once shows a July–May price decline, but this decline (in 1910–11) amounted to 14 cents. No. 1 Northern Spring wheat shows four November–July price decreases, the greatest, that in 1900–01, being 11 cents at the 1913 price level. There are similarly numerous cases in all three wheats of increases of 15 and 20 cents or more above the average increase and one case in each of the winter wheats of an increase of 35 cents or more in excess of the average increase.

Table 2.—Changes in Wheat Prices from Post-Harvest to Pre-Harvest Months, Annually, 1899–1900 to 1913–14 and 1921–22 to 1927–28*

(Cents per bushel at 1913 price level)

Crop year	No. 2 Hard Winter, July–May	No. 2 Red Winter, July–May	No. 1 Northern Spring, Nov.–July
1899–00	— 5.0	0.0	+16.3
1900–01	+ 1.3	0.0	—11.4
1901–02	+13.5	+18.4	+ 9.8
1902–03	— 1.2	+ 4.6	+16.2
1903–04	+25.9	+33.0	+20.0
1904–05	+16.3	+12.8	+ 1.2
1905–06	— 4.6	+ 5.8	— 5.8
1906–07	+20.8	+15.4	+24.1
1907–08	+14.2	+14.2	+12.0
1908–09	+44.1	+50.6	+24.8
1909–10	— 6.9	+ 3.0	+15.8
1910–11	—14.7	—13.7	— 5.3
1911–12	+25.1	+38.6	+ 4.2
1912–13	— 5.0	+ 1.0	+ 7.0
1913–14	+ 8.1	+11.1	+ 7.1
1921–22	+11.2	+10.5	+16.9
1922–23	+ 1.9	+13.5	— 7.1
1923–24	+ 6.7	+10.0	+15.3
1924–25	+27.8	+32.9	+ 7.1
1925–26	+ 0.6	+ 1.9	+10.9
1926–27	+ 3.4	0.0	+ 0.7
1927–28	+16.3	+37.3	+ 5.4
Average	+ 9.1	+13.7	+ 8.4

* Computed from deflated weighted average cash prices at Kansas City, St. Louis, and Minneapolis, respectively. Sources as for Table 1, p. 3.

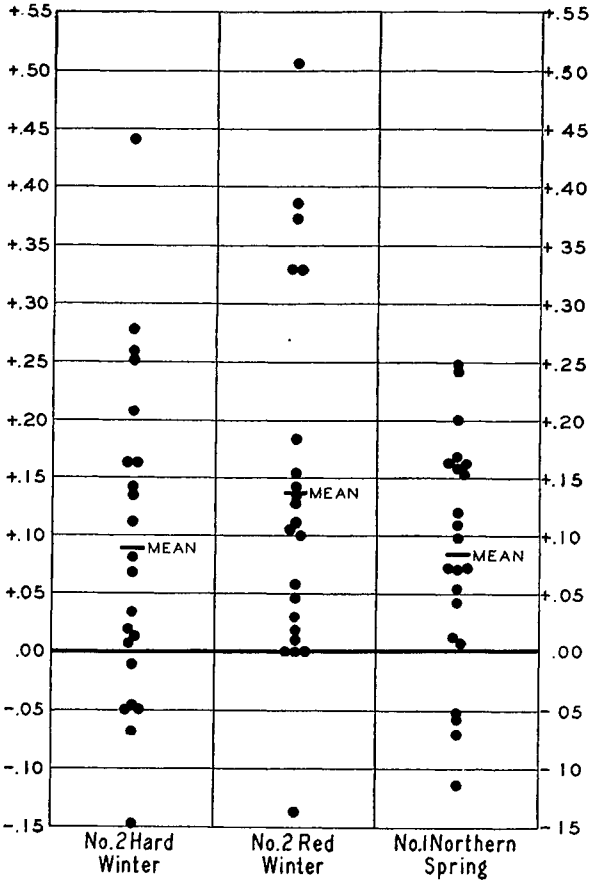
Variations among Averages

No average of post-harvest price movements may be regarded as typical of the

usual price movement from the end of one harvest to the month preceding the next; there is no usual movement. An average

CHART 2.—DISTRIBUTION OF ANNUAL CHANGES IN WHEAT PRICES FROM POST-HARVEST TO PRE-HARVEST MONTHS, 1899–1900 TO 1913–14 AND 1921–22 TO 1927–28*

(Cents per bushel at 1913 price level)



* The changes shown are from July to May for the winter wheats and from November to July for spring wheat. Data from Table 2, p. 5. These changes, presumably influenced by the post-harvest depression of wheat prices, show wide variations from year to year owing to unexpected developments during the course of the season. The averages, indicated by the short horizontal lines, may be greatly influenced by changes in a few unusual years and cannot be regarded as reflecting accurately the general tendencies.

for one period of years may, however, be regarded as in some degree representative of the general tendency toward a price increase over the months in question. Averages of the changes in price of No. 2 Hard Winter wheat at Kansas City from July to May for successive five-year periods are as follows, in cents per bushel, at the 1913 price level:

6.9	18.2	1.3	9.6
10.0	11.5	8.3	11.0

The first line of averages above is obtained from successive five-year periods beginning with 1899–1900, the second line of averages from successive five-year periods beginning with 1901–02.

The difference between the average of 18.2 cents for the five years 1904–05 to 1908–09 and the average of 1.3 for the next five years 1909–10 to 1913–14—periods in which the general tendency to post-harvest depression must have been substantially the same—illustrates the degree to which such averages may misrepresent the general tendency they are supposed to measure. The difference between these two 5-year averages being 16.9 cents, it follows either that both of them misrepresent the general tendency by nearly 8.5 cents or that one of them misrepresents it by more than that amount.

If several 22-year averages of July–May price changes for No. 2 Hard Winter wheat at Kansas City were available, all covering periods in which the general tendency toward post-harvest depression was the same, it would be surprising if they did not show differences among themselves nearly half as large as the differences among the five-year averages listed above. The general rule is that the variation among averages calculated from homogeneous data is proportional to the square root of the number of items included in each average.[1] The variation among 22-year averages tends, in general, to be $\frac{\sqrt{5}}{\sqrt{22}}$, or 0.476 as much as the variation among five-year averages. Since at least one of the five-year averages clearly misrepresents the general tendency by 8.45 cents or more, it appears possible that the one available 22-year average may misrepresent this general tendency by 4 cents or more.

[1] This rule must be modified more or less if the data are taken in a definite order—chronologically, for example, as in the present case—and if there exist relationships among the items such that one item may be predicted more or less accurately from previous items. As will be noted subsequently, it is probable that we have to deal here with such a case in which the general rule must be modified.

Measurement of Reliability of the Averages

While the above reasoning makes clear the possibility that the one available 22-year average July–May price change for No. 2 Hard Winter wheat may misrepresent the general tendency by 4 cents or more, it fails to indicate whether this is a probability seriously to be reckoned with, or only a remote possibility. For this purpose, a calculation of the standard error of the average is necessary.

The usual rule for calculation of the standard error of an average calls for basing it on the variation observed among the original items included in the average. The standard error of the average is taken to be equal to the estimated standard deviation of the original items divided by the square root of the number of items included in the average. The variation among the five-year averages, however, is considerably less than would be expected on this basis: the first group of four five-year averages with its two extreme values shows slightly more variation than would be expected on the basis of this rule, while the second group of four five-year averages shows less than one-fourth of the variation expected. These facts suggest that the July – May price change for No. 2 Hard Winter wheat at Kansas City in any one year is related to and in some degree predictable from the changes in previous years, since this is the only circumstance, apart from chance, that would account for such a discrepancy.[1]

The large discrepancy represented by the fact that one group of five-year averages shows less than one-fourth the amount of variation expected is not sufficient to prove conclusively that the data under consideration show serial correlations that must be taken into account in computing the standard errors of averages; but, taken with other facts, it justifies that assumption. The very fact that in one year, or perhaps in two or three years in succession, large profits have been made in the carrying of wheat (either cash wheat or futures) from fall to spring may be expected to lead to some bidding up of prices in a succeeding fall which will render a large gain from carrying wheat in that year less probable than would otherwise have been the case. Recent investigations of the behavior of wheat prices, carried on in the Food Research Institute, point also to the existence of other, possibly more important, tendencies in this direction.[2]

This situation may be dealt with most simply by basing the calculation of the standard error of the 22-year average on the variation observed among averages for shorter periods.[3] Successive four-year averages appear most appropriate for this purpose. Since there is no justification for assuming that the July–May changes in the first post-war years are correlated with the changes in the last pre-war years, the best use of the available data may be made by calculating four sets of successive four-year averages, each set starting with a different initial year and including three averages for pre-war years and one average for post-war years. The four sets of four-year averages yield standard deviations of 5.35, 1.31, 8.06, and 6.11 respectively, the average of which is 5.76.[4] The standard error of the 22-year average, estimated at $\sqrt{4} / \sqrt{22}$, or 0.426 of the average variation of the four-year averages, is 2.45 cents per bushel.[5]

This standard error indicates, in line with our earlier conclusion (p. 6), that it is quite possible that the 22-year average July–May price change for No. 2 Hard Winter wheat at Kansas City of 9.1 cents per bushel misrepresents the general tendency to post-harvest depression during the period covered by 4 cents or more. It enables one to state further that the chances that the general tendency is misrepresented by this amount or more are about one in nine.

Range of Reasonable Conclusions

The probabilities that the general tendency to post-harvest depression of No. 2

[1] See the previous footnote, p. 6.

[2] A paper presenting the results of these investigations is planned for early publication.

[3] The theory underlying this method is presented in a paper by Holbrook Working and Harold Hotelling on "Application of the Theory of Error to the Interpretation of Trends," *Journal of the American Statistical Association*, March 1929, Supplement, XXIV, 73–85.

[4] Not the arithmetic mean, of course, but the square root of the mean of the squares of the four standard deviations.

[5] Estimated from the variation among the original items, the standard error would be 2.99 cents.

Hard Winter wheat during the 22 years under discussion equaled or exceeded certain values above the average of 9.1 cents may be tabulated as follows:

Value	Probability[1]
10.1	0.34 —or 1 in 3
11.1	0.21 —or 1 in 5
12.1	0.11 —or 1 in 9
13.1	0.058—or 1 in 17
14.1	0.027—or 1 in 37
15.1	0.012—or 1 in 83

The probability that the general tendency equaled or fell below certain values under the average of 9.1 cents may be tabulated similarly:

Value	Probability[1]
8.1	0.34 —or 1 in 3
7.1	0.21 —or 1 in 5
6.1	0.11 —or 1 in 9
5.1	0.058—or 1 in 17
4.1	0.027—or 1 in 37
3.1	0.012—or 1 in 83

A common rule for the interpretation of statistical results in connection with their standard errors is that probabilities of 2.5 per cent (one chance in 40) or less may be neglected with reasonable safety.[2] On the basis of this criterion, the statistics may be taken as proving, for practical purposes, that the tendency to post-harvest price depression for No. 2 Hard Winter wheat at Kansas City lay somewhere between 4.0 cents and 14.2 cents. The statistics suggest that the tendency was for a 9-cent depression, but they do not disprove the contentions of any who would argue that the tendency was for a 14-cent depression. Neither can the statistics be cited as disproving the contention of any who may claim that the tendency was for a depression of only 4 cents.

Using the same methods of calculation and the same standard for determining "maximum" and "minimum" values, similar results may be obtained for No. 2 Red Winter wheat at St. Louis and No. 1 Northern Spring wheat at Minneapolis. The results for all three wheats, expressed in cents per bushel at the 1913 price level, are brought together in the following tabulation:

	No. 2 Hard Winter	No. 2 Red Winter	No. 1 Northern Spring
22-year average price change	9.1	13.7	8.4
Standard error of average[3]	2.45	2.16	1.76
Maximum reasonable estimate of tendency to price change	14.2	18.2	12.1
Minimum reasonable estimate of tendency to price change	4.0	9.2	4.7
22-year average change per month	0.9	1.37	1.05
Maximum reasonable estimate on monthly basis	1.42	1.82	1.51
Minimum reasonable estimate on monthly basis	0.40	0.92	0.59

A word should be said in explanation of the figures shown above on a monthly basis. The existence of a post-harvest depression of prices implies necessarily an increase in prices from the low point following the harvest to a subsequent high point. It is this subsequent rise which is expressed on a monthly basis. These figures are most useful in comparing the price change for spring wheat, covering eight months from November to July, with the price changes for the winter wheats, covering ten months from July to May. In making comparisons involving No. 2 Hard Winter wheat, it must be remembered that the total average change would have been 0.8 cent larger if taken between August and May; since the interval between August and May is nine months instead of ten, the average monthly change on this basis is 1.1 cents per bushel.

[1] These probabilities are taken by interpolation from Fisher's "Table of t," taking $n = 21$; see R. A. Fisher, *Statistical Methods for Research Workers* (Edinburgh and London, Oliver and Boyd, 2d edition, 1928), p. 139. There is some question as to what value should be assigned to n in view of the apparent serial correlations in the series, but the above values of the probabilities may be considered very nearly correct and certainly better than the values indicated by tables of the normal probability integral.

[2] Many statisticians prefer to adopt much more rigid standards. This seems to be the largest probability that is regarded as practically negligible by any considerable group of prominent statisticians.

[3] If estimated from the standard deviations of the original annual items instead of from the standard deviations of the four-year averages, these standard errors would be, in order, 2.99, 3.36, and 2.15, that is, 22, 55, and 22 per cent larger, respectively. Each of the three wheat price series, therefore, shows evidence of serial correlations requiring the use of some such special method as is here employed to approximate the true standard errors of averages.

Perhaps the most important conclusion to be drawn from the above data is that averages of price changes do not provide a basis for stating with any great precision the magnitude of the general tendency to post-harvest depression of prices of any particular class and grade of wheat. The range between the larger and the smaller figures that may reasonably be taken as possibly representative of the general tendency, as shown in the above table, may still be small enough to render the figures useful for certain purposes. Facts developed in subsequent pages permit us to arrive at maximum and minimum figures which stand much closer together (see below, pp. 27–28), but they depend upon an assumption, the validity of which cannot be definitely proved. For purposes in which the wide range of the above figures does not destroy their usefulness, they retain a superiority on the ground of involving no questionable assumptions.[1]

The temptation is strong to compare the estimates of price change in the foregoing tabulation with the costs of storage of wheat. Even the figures representing the maximum reasonable estimates of the tendencies to price increases following the post-harvest depression fall short of apparently reasonable estimates of the cost of storing wheat over corresponding periods, or, at most, exceed them by only a small margin. Such comparisons can throw no light on profits from storage nor on the reasonableness of the post-harvest depression. Averages of price changes are by no means to be taken as representing average gains from storage, as will be shown in the following section.

II. CASH–FUTURE SPREADS

In much of the discussion of the post-harvest depression of wheat prices it is assumed that grain dealers are interested in seeing wheat prices depressed at the season of heavy marketing shortly after harvest. This assumption has very little foundation. It overlooks the fact that most, if not all, large grain dealers in the United States systematically hedge their purchases of wheat. To the holder of hedged wheat it makes little difference whether wheat prices in general rise or fall after he has made his purchase. He hopes rather to see the prices of the particular classes and grades of wheat which he holds move into a more favorable relationship to futures prices. If grain dealers exercise any concerted influence on wheat prices in order to increase their profits from carrying the grain, that influence must be directed toward affecting the cash–future spread.

A depression of cash wheat prices relative to futures may be effected through an absolute depression of cash prices or it may be effected through an elevation of futures prices. Presumably the general tendency is for depression of cash prices relative to futures to be accompanied by absolute depression of cash prices, but the relation is by no means regular. Years in which both cash and futures prices are high in the fall are frequently years in which handsome profits are realized by holders of hedged wheat.[2] Conversely, years in which both cash and futures prices are low in the fall may be years in which holders of hedged wheat lose.[3] Clearly, a study of the post-harvest depression of cash–future spreads[4] will give a more di-

[1] The accuracy of certain assumptions made in computing the "maximum" and "minimum" figures is of course open to question, but substitution of other reasonable assumptions would lead to only small changes in the figures.

[2] Between August 1927 and January 1928, the price of the Chicago May future declined 18.6 cents, while cash prices of No. 2 Hard Winter, No. 2 Red Winter, and No. 1 Northern Spring wheat rose, relative to the future, 17, 28, and 11 cents, respectively.

[3] Between October 1925 and January 1926, the Chicago May future rose over 32 cents, while prices of No. 2 Hard Winter, No. 2 Red Winter, and No. 1 Northern Spring wheat, though rising absolutely, fell, relative to the future, 12, 8, and 8 cents, respectively.

[4] The expression "depression of cash–future spreads" is used here and subsequently in this study as a convenient designation for a phenomenon which cannot be characterized precisely in any brief expression. In speaking of depression of a cash–future spread, we mean, not that the spread is absolutely small, but that the cash price is relatively low compared with the price of a given future; in subsequent pages we deal entirely with the Chicago May future. As the tendency toward a post-harvest depression of cash prices is thought of in terms of the tendency for cash prices to rise from fall to spring, so the tendency toward a post-harvest depression of cash–future spreads is thought of in terms of the tendency for cash prices to rise relative to the price of the Chicago May future. Chart 3 (p. 11) shows this tendency as revealed in 22-year averages.

rect measure of the degree to which grain dealers profit from such post-harvest depression as exists than does any study of the post-harvest depression of cash prices by itself.

The study of cash–future spreads was entered upon with the expectation of determining more accurately the general tendency to post-harvest depression of cash prices relative to futures, and the actual average gross gains to dealers. It revealed instead, as presented in the following pages, facts which invalidate the traditional theory of a uniform general tendency to post-harvest depression of wheat prices which should approximate the cost of storage. There is not one general tendency—rather there are many tendencies, changing from year to year; and there is no ground for supposing that an ordinary average of these tendencies, or an average of the actual changes, either does or should approximate the costs of storage of wheat, for such averages generally understate the actual average gains from storage.

Changes in cash–future spreads—that is, changes in prices of cash wheat relative to futures—from fall to spring are found, for at least two of the three important classes and grades of wheat studied, to be readily predictable with fair accuracy in the late summer and fall. In some years cash prices shortly after the harvest are much lower, relative to the May future, than they are expected to be in the spring; in other years they are little lower, or possibly higher, relative to the May future, than they are expected to be in the spring. The post-harvest depression of cash prices, viewed in this light, is clearly a variable; the tendency to post-harvest depression changes greatly from year to year.

If changes in cash–future spreads, and therefore gains from storage of hedged wheat, are easily predictable just after the harvest, it is not reasonable to suppose that dealers store wheat equally in years when large gross gains are to be expected and in years when little or no gain is to be expected. By storing heavily only in the years of larger anticipated gross gains they can raise substantially their average gain per bushel of wheat actually stored. Nor is great astuteness required to do this, for the years of large gross gains from storage of hedged wheat are the years in which there is much wheat to be stored; the years of small gains or of losses on storage of hedged wheat are the years in which there is little wheat available for storage. Average gross gains per bushel of wheat actually stored are clearly, for certain important classes and grades at least, substantially above the simple averages of changes in cash prices relative to futures.

These facts make necessary a reformulation of the concept of the post-harvest depression of wheat prices and a radical change in methods of appraising the reasonableness of the post-harvest depression, at least in so far as the post-harvest depression is measured by the depression of cash prices relative to futures. It is clear that most of the post-harvest depression of cash prices is reflected in the post-harvest depression of cash–future spreads. We find reason, further, to believe that there is no real tendency to post-harvest depression of futures prices (see pp. 25–27). If this be true, then the whole post-harvest depression is measured by the post-harvest depression of cash prices relative to futures, and what we have said of the post-harvest depression, measured thus, is applicable to the post-harvest depression of cash prices in the broadest sense.

In proving, in the following pages, that the post-harvest depression must be viewed not as a uniform general tendency but as a tendency changing greatly from year to year, we simultaneously provide the framework for a more adequate concept of the post-harvest depression of wheat prices. The new concept grows naturally out of the old. The demonstration that little light is thrown on the reasonableness of the post-harvest depression by a comparison of the average post-harvest depression with costs of storage, however, destroys one supposed basis of testing the reasonableness of the depression without providing directly any new basis. Some light is thrown on the form that a valid test must take, and while an adequate test is revealed as an extremely difficult one to make with precision, we bring together data sufficient to indicate in a general way the reasonableness of the post-harvest depression as it is observable over 15 pre-war and 7 post-war years.

Average Seasonal Changes

The Federal Trade Commission has made an extensive study of changes in the cash–future spread in different markets for wheat and for other grains, and of the relations of spreads to the computed costs of carrying grain in storage.[1] The study, however, deals solely with the spread between prices of futures and the prices of the cheapest grain deliverable on the futures. This was the most appropriate procedure in view of the immediate purpose of the Commission's study, but the results fail in consequence to show the change in the cash–future spread as it affects dealers holding substantial quantities of wheat above and below the grades and qualities just satisfying the delivery requirements.

It is not possible to obtain entirely satisfactory data for studying the change in the cash–future spread as it has affected the average elevator in past years. Reasonably satisfactory results may be obtained, however, from a study of the spread, month by month, between the Chicago May future and the weighted averages of cash prices of the three principal classes and grades of wheat considered above.[2] The limitations of the data will be considered in connection with the interpretation of the results.

The monthly averages of the price of the Chicago May future over the 22 years, 1899–1914 and 1921–28, are shown in the first column of the following tabulation, in terms of cents per bushel at the 1913 price level.[3] In parallel columns are shown the spreads between these averages and the monthly averages of the three cash wheat price series. The spreads are shown graphically in Chart 3.

[1] *Prices of Grain and Grain Futures* (Report . . . . on the Grain Trade, VI), 1924.

[2] The use of these spreads implies the assumption that stored wheat is hedged in the Chicago May future. While much stored wheat is hedged initially in other markets and in other delivery months, with the result that in individual years the realized changes in spreads differ from those here employed, we find no reason to believe that the differences substantially affect the conclusions.

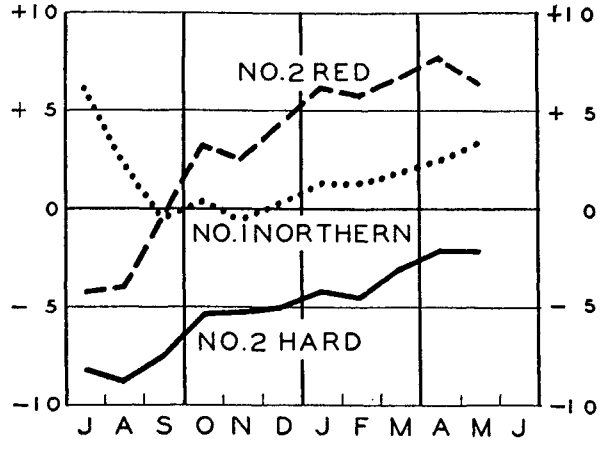
[3] The prices and spreads have been reduced to cents per bushel at the 1913 price level, as in the preceding section, by dividing the original figures for each month by the average Bureau of Labor Statistics "all commodities" wholesale price index number (base, 1913 = 100) for the crop year July–June in which that month falls.

The three sets of average spreads show a fairly steady change in the spreads from October to April or May, representing a progressive rise in the price of cash wheat relative to the Chicago May future. For both hard winter and northern spring wheat the increase in price of cash wheat

Month	Chicago May future	Deviation from Chicago May future		
		No. 2 Hard Winter (Kansas City)	No. 2 Red Winter (St. Louis)	No. 1 Northern Spring (Minneapolis)
July	97.0	—8.2	—4.3	+6.1
Aug.	96.8	—8.8	—4.0	+2.2
Sept.	96.7	—7.5	—0.3	—0.5
Oct.	96.3	—5.4	+3.1	+0.3
Nov.	95.7	—5.2	+2.5	—0.6
Dec.	97.1	—5.0	+4.2	+0.2
Jan.	98.8	—4.2	+6.1	+1.2
Feb.	99.5	—4.6	+5.8	+1.2
Mar.	97.7	—3.1	+6.6	+1.8
Apr.	97.1	—2.2	+7.6	+2.4
May	100.1	—2.2	+6.3	+3.3

Chart 3.—Average Monthly Cash–Future Spreads for Three Important Classes and Grades of Wheat in United States Markets*

(Cents per bushel at 1913 price level)



* Data from Appendix Table I. See also the tabulation above. The spreads represent in each case the differences between the cash prices and the price of the Chicago May wheat future. The average seasonal rise of cash prices relative to the future is similar to the average absolute rise of cash prices (see Chart 1, p. 4), but more regular and slightly smaller. Dealers, whose stored wheat is regularly hedged, gain from changes in cash–future spreads rather than from changes in cash prices by themselves. We regard the differences between the average changes in cash–future spreads and the average absolute changes in cash prices as a peculiarity of the particular period covered by the data and not as a reflection of a general tendency (see pp. 27–28).

relative to the future after about the first of October is at the rate of 0.5 cent a month and continues until May. For red winter wheat the rise is less regular and continues only until April, the average rate of increase during this period being 0.9 cent a month. Prior to October, the two winter-wheat series show a much more rapid rise of cash wheat relative to the future than subsequently. This is most marked in the case of the red winter series. The total change in spread between August and April for the red winter wheat series is 11.6 cents, or at the rate of 1.45 cents a month. The total change in spread between August and May for the hard winter wheat series is 6.6 cents, or at the rate of 0.73 cent a month.

Changes between Three-Month Periods

The averages of seasonal change in cash–future spreads, calculated from the data for a 22-year period, may no more be taken as accurately representing the general tendency they are intended to measure than could the averages of changes in cash prices, discussed in the previous section. It is necessary again to calculate limits within which the general tendency may confidently be said to lie. For this purpose it is convenient once more to concentrate attention on changes between certain periods.

Several facts make it desirable in the present case to deal with changes between three-month periods rather than between one-month periods. An examination of the spreads, month by month (as given in Appendix Tables III–V) will show that in general the spreads change fairly uniformly from month to month, but that in some years they fluctuate in an erratic manner. These fluctuations are in part due to special circumstances affecting the Chicago May wheat future. The most conspicuous instance of this sort occurred in the spring of 1905, when an attempted corner in the Chicago May future carried the price of that future far out of line with the prices of cash wheats in other markets. With the collapse of the corner late in April, the Chicago May future fell considerably below its usual relationship to cash wheats in other markets. A certain amount of fluctuation in the spreads results also from the use of weighted averages of cash prices in connection with simple averages of futures prices. If during the early part of one month prices are high and sales of cash wheat heavy, while during the latter part of the month prices are lower and sales light, the weighted average of the cash prices will be above an unweighted average. When this weighted average is compared with the unweighted average of prices of the Chicago May future, the cash prices will appear higher in relation to the future than was actually the case. The average spread for the month, thus calculated, may even be less than the actual spread at any time during the month. With a reversal of the conditions, the average spread thus calculated may be greater than the actual spread at any time during the month. This difficulty might be avoided, of course, by using simple averages of cash prices, but such averages are less adequately representative of the general run of wheat, of the class and grade, as received in the primary market. The advantages of the monthly weighted averages over simple averages more than offset their disadvantages. The ideal cash price series for present purposes would be one giving simple monthly averages of daily weighted averages, but no such series are available. The fluctuations in calculated spreads arising from this latter source, at least, represent unavoidable errors in the data, the effects of which will tend in some degree to obscure the general tendency to change in the spreads. The influence of such errors will be less in a comparison of three-month averages than in a comparison of one-month averages.

A further advantage in the comparison of three-month averages is found in the fact that it is not ordinarily feasible for a dealer to buy in a single month all the wheat he wishes to store, and after carrying it through the winter to sell it all in another single month. The change in spread between the three months of heavy wheat marketing following the harvest and the three spring months gives a better indication of dealers' possible gains from storing wheat than the change in spread, however accurately calculated, between two single months.

The three post-harvest months for which

we have calculated the average spreads for subsequent analysis are, for the winter wheats, July, August, and September, and for spring wheat, September, October, and November. The three spring months are, for all the wheats, March, April, and May. The 22-year averages and the changes are as follows, in cents per bushel at the 1913 price level:

	No. 2 Hard Winter	No. 2 Red Winter	No. 1 Northern Spring
Average spread, three post-harvest months ..	—8.16	—2.87	—0.24
Average spread, three spring months	—2.47	+6.82	+2.50
Average change	+5.69	+9.69	+2.74

The changes between the months showing the greatest average difference are, in order, 6.6, 11.9, and 3.9 cents per bushel. The changes between the three-month averages are thus not much below the changes between the months showing the maximum change. In terms of change per month, the two bases of statement show even more closely similar results, as appears from a comparison of the third and sixth lines in the following tabulation:

	No. 2 Hard Winter	No. 2 Red Winter	No. 1 Northern Spring
Maximum change between monthly averages	6.60	11.90	3.90
Number of months interval	9	9	9
Change per month.....	0.73	1.33	0.65
Change between three-month averages	5.69	9.69	2.74
Number of months interval	8	8	6
Change per month.....	0.71	1.21	0.46

Variations in Changes

The rise in price of cash wheat relative to the Chicago May future between the three post-harvest months and the three spring months in each year is given in Table 3 (p. 14) and shown graphically in Chart 4 (p. 15) for each of the three classes and grades of cash wheat. Appendix Table IX and Chart 4 show also certain related series. The changes in spread vary widely from year to year. For No. 2 Hard Winter wheat there were three years (1902–03, 1909–10, and 1925–26) out of the 22 in which cash wheat averaged lower in price, relative to the Chicago May future, in March–May than in July–September. If the weighted average prices are representative of the prices paid and received for No. 2 Hard Winter wheat by dealers storing that wheat in the Kansas City district, such storage showed a loss in those years. The loss may indeed have been offset by profits from mixing, or judicious merchandising, but that is another matter.

It does not follow, however, that much money was lost by dealers on the storing of such wheat. In all three of these years the cash–future spread in the post-harvest months was unfavorable to the purchase of wheat for storage, cash wheat in the post-harvest months being high relative to the futures. In all three years, also, there was relatively little wheat to be stored owing to a light carryover from the previous years, a short crop in the hard winter-wheat states, or both. The chances are that in these years little wheat was bought in the post-harvest months for storage through the winter.

In the case of No. 2 Red Winter wheat, the changes in spread indicate a loss on stored wheat in two years, 1909–10 and 1925–26. The former was the year of lowest July 1 United States wheat stocks during the 22 years for which the spreads have been calculated. The latter year was one of low July 1 stocks combined with a short crop in the principal red winter-wheat states.

The figures for No. 1 Northern Spring wheat show apparent losses on stored wheat in six years, though in only two of these years did the apparent loss amount to as much as one cent. All six years were years of low July 1 wheat stocks, short spring-wheat crops, or both.

The calculations for all three wheats show occasional years of unusually large gross gains from storage. In the cases of

both No. 2 Hard Winter wheat and No. 1 Northern Spring wheat, the years of largest gains from storage are quite uniformly years of heavy July 1 stocks of wheat or years of large crops, or both. The years of largest increase in price of red winter bought at that time and hedged, they can avoid storing in most of the years when storage would prove unprofitable and store heavily in most of the years when gains from storage are high. Their actual average gains from storage can thus be raised

TABLE 3.—AVERAGE DEFLATED CASH–FUTURE SPREADS IN THREE POST-HARVEST MONTHS AND THREE SPRING MONTHS, AND CHANGES, FOR THREE CLASSES AND GRADES OF WHEAT, BY YEARS, 1899–1900 TO 1913–14 AND 1921–22 TO 1927–28*

(Cents per bushel at 1913 price level)

Crop year July-June	No. 2 Hard Winter at Kansas City			No. 2 Red Winter at St. Louis			No. 1 Northern Spring at Minneapolis		
	Average		Change	Average		Change	Average		Change
	July-Sept.	March-May		July-Sept.	March-May		Sept.-Nov.	March-May	
1899-00	—13.0	—3.4	+ 9.6	— 6.4	+ 7.1	+13.5	— 7.7	— .5	+ 7.2
1900-01	—17.6	—4.9	+12.7	— 8.3	+ 1.4	+ 9.7	— 3.7	— .7	+ 3.0
1901-02	—11.5	—1.6	+ 9.9	— 6.6	+ 8.6	+15.2	— 7.7	— .8	+ 6.9
1902-03	— 4.8	—8.9	— 4.1	— 4.4	— 3.2	+ 1.2	— 3.6	+ .7	+ 4.3
1903-04	—11.7	—4.0	+ 7.7	+ .2	+15.2	+15.0	+ 2.7	+ 1.5	— 1.2
1904-05	— 8.0	—7.7	+ .3	+ 3.2	+ 5.5	+ 2.3	+ 1.2	+ 3.1	+ 1.9
1905-06	— 7.5	—1.7	+ 5.8	— .6	+15.5	+16.1	— 4.2	— .2	+ 4.0
1906-07	—12.6	—5.0	+ 7.6	— 8.2	— 1.3	+ 6.9	— 1.7	+ 4.5	+ 6.2
1907-08	—15.2	+1.2	+16.4	—13.4	+ 4.1	+17.5	+ 2.6	+ 9.9	+ 7.3
1908-09	— 2.7	+4.6	+ 7.3	— 3.1	+12.5	+15.6	+ .6	— .1	— .7
1909-10	+ 2.7	—2.9	— 5.6	+ 9.5	+ 5.6	— 3.9	+ 1.1	+ .7	— .4
1910-11	— 7.4	—2.9	+ 4.5	— 4.6	+ 1.0	+ 5.6	+ 6.3	+ 6.6	+ .3
1911-12	— 8.8	— .5	+ 8.3	—12.0	+ 4.0	+16.0	+ 5.5	+ 2.6	— 2.9
1912-13	— 9.2	—3.8	+ 5.4	+ 4.7	+16.2	+11.5	— 7.2	— 2.8	+ 4.4
1913-14	—11.7	—5.5	+ 6.2	— 6.7	+ 1.2	+ 7.9	— 6.6	— 1.4	+ 5.2
1921-22	— 8.0	—2.2	+ 5.8	— 1.7	+ 2.0	+ 3.7	+12.4	+13.5	+ 1.1
1922-23	— 3.2	—2.3	+ .9	— .2	+ 9.2	+ 9.4	+ 3.0	+ 4.2	+ 1.1
1923-24	— 4.6	+1.2	+ 5.8	— 4.8	+ 5.6	+10.4	+ 5.4	+11.1	+ 5.7
1924-25	— 9.7	—1.5	+ 8.2	+ 2.0	+12.3	+10.3	— 5.0	— .9	+ 4.1
1925-26	+ 1.0	—1.6	— 2.6	+ 6.5	+ 4.5	— 2.0	+ 1.7	+ 1.0	— .7
1926-27	— 8.4	—2.1	+ 6.3	— 5.7	— 3.3	+ 2.4	+ 2.2	+ 2.0	— .2
1927-28	— 7.7	+1.2	+ 8.9	— 2.5	+26.3	+28.8	— 2.5	+ 1.0	+ 3.5
Average	— 8.16	—2.47	+ 5.69	— 2.87	+ 6.82	+ 9.69	— 0.24	+ 2.50	+ 2.74

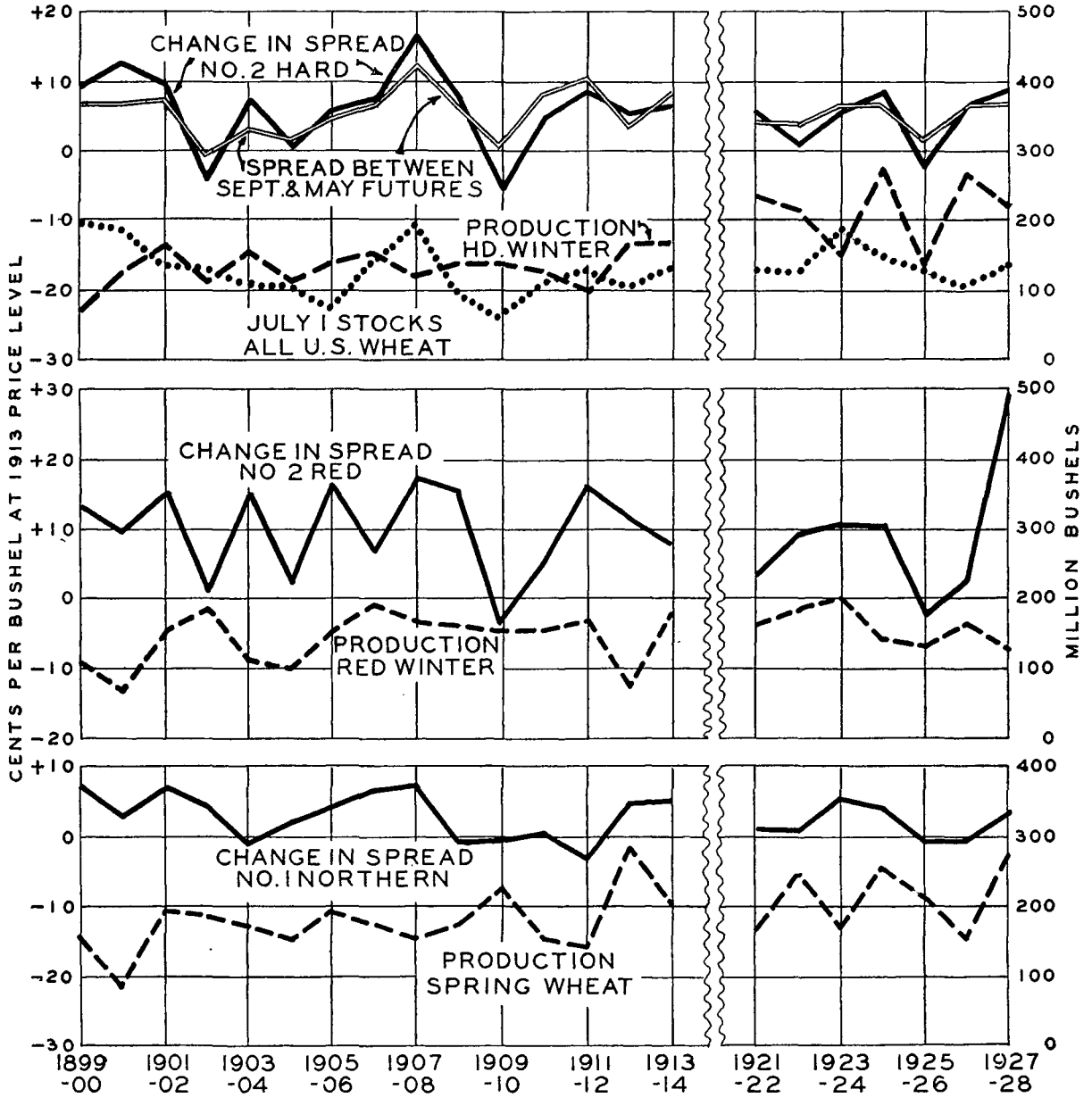
* The spreads show the amounts in cents per bushel at the 1913 price level that the weighted average cash prices at the markets designated fell below (—) or exceeded (+) the simple averages of daily high and low prices of the Chicago May future. The changes show the increase (+) or decrease (—) in the price of the cash wheats relative to the Chicago May future during the interval. Data from Appendix Tables VI, VII, and VIII.

wheat, relative to the Chicago May future, are not at all uniformly years of either large July 1 stocks or large crop in the principal red winter-wheat states.

PREDICTION OF CHANGES

If wheat dealers are able shortly after the harvest to judge with some accuracy the profits to be expected from storage of wheat above the figures indicated by simple averages of changes in cash–future spreads. An examination of Chart 4 indicates that there is some relationship between the changes in cash–future spreads for each wheat and the total July 1 United States wheat stocks, as well as some relationship between the changes in cash–future spreads and the size of the wheat crop in the states producing the bulk of the class of wheat in

CHART 4.—CHANGES IN CASH–FUTURE SPREADS FROM THREE POST-HARVEST MONTHS TO THREE SPRING MONTHS FOR THREE IMPORTANT CLASSES AND GRADES OF WHEAT, AND RELATED SERIES*



* Data from Appendix Table IX. The spread, in August, between the Chicago September and May futures, which reflects a conscious market appraisal of the difference in value between wheat deliverable in September and wheat deliverable in May, gives an indication of the post-harvest depression of wheat prices closely related to the actual subsequent change in price of No. 2 Hard Winter wheat relative to the price of the May future. The "tendency to post-harvest depression" is not a constant tendency, but changes greatly from year to year. In the case of hard winter and of northern spring wheat, at least, the post-harvest depression is influenced by the amount of the carryover from the previous year and by the size of the current year's crop (see pp. 13–16).

question. The closeness of a relationship between one series and two other series is so difficult to judge from a study of charts, however, that the calculation of multiple correlation coefficients is necessary to make sure of the facts.

Correlation of the data[1] yields the following coefficients:

No. 2 Hard Winter wheat ..... $R = 0.726$ ($R^2 = 0.527$)

No. 2 Red Winter wheat $R = 0.407$ ($R^2 = 0.166$)

No. 1 Northern Spring wheat ..... $R = 0.744$ ($R^2 = 0.553$)

The squares of the coefficients are shown also, as these give a truer indication of relative significance of correlation coefficients than the coefficients themselves.

When allowance is made for the spurious element usually present in multiple correlation coefficients, the above results indicate no significant relation between profits from storage of red winter wheat, hedged, and either volume of July 1 United States wheat stocks or the size of the crop in the principal red winter-wheat states.[2] As regards the other two wheats, however, it is clear that profits from storage may be predicted with fair accuracy at the time the wheat would normally be put in storage. It is possible, therefore, for elevator operators to anticipate the years in which storage of hard winter or northern spring wheat would prove unprofitable and so to avoid losses by keeping stocks low in those years; similarly, they can anticipate the years in which storage will be profitable, and in those years, carry large stocks through the winter. Indeed, it requires no great sagacity on the part of the elevator operator to make the necessary adjustment in stocks carried, for the years when stocks should be kept small are years in which little wheat is available for storage; years in which large stocks should be carried are the years in which heavy carryover and large crops force unusually large quantities of wheat into the elevators.

The correlations cited above are indeed most significant as proof that, for hard winter and northern spring wheat at least, the years in which the larger gains per bushel accrue on storage of hedged wheat are years in which elevators are naturally called upon to carry larger quantities of wheat through the winter. They must be assumed to understate considerably the accuracy with which dealers can predict gains from storage. Gains from storage of No. 2 Hard Winter wheat may be predicted more accurately merely on the basis of the spread between the September and the May future in Chicago. The correlation between the change in the cash–future spread for this wheat and the spread during August between the Chicago September and May futures is 0.892.[3] Further investigation would

[1] The data, with references to sources, appear in Appendix Table IX. In the computations, trends were taken care of by including time among the independent variables. The regressions of change in spread on the other independent variables (other than time) obtained by the method used are identical with those that would have been obtained if linear trends had been fitted separately by the method of least squares to the pre-war and post-war portions of each series and the deviations from trend correlated. The multiple correlation coefficients are very little, if at all, larger than would have been obtained by this method, since there are no perceptible trends in the dependent variables. The regression coefficients may be tabulated as follows:

AVERAGE INCREASE OR DECREASE IN CHANGE IN CASH–FUTURE SPREAD BETWEEN THREE POST-HARVEST MONTHS AND THREE SPRING MONTHS, IN CENTS PER BUSHEL PER MONTH AT 1913 PRICE LEVEL

	Accompanying 50-million bushel increase in July 1 stocks	Accompanying 50-million bushel increase in crop in principal states
No. 2 Hard Winter wheat at Kansas City	+0.78	+0.45
No. 2 Red Winter wheat at St. Louis	+0.45	−0.04
No. 1 Northern Spring wheat at Minneapolis	+0.54	+0.32

No great significance is to be attached to the values of any of these regression coefficients, as their probable errors are all relatively large. As noted in the text, the results for No. 2 Red Winter may be entirely misleading.

[2] Correcting the coefficients for the number of independent variables reduces the coefficient for No. 2 Red Winter to an imaginary quantity ($\bar{R}^2 = -0.147$), indicating that a coefficient slightly over 0.407 would ordinarily be obtained from a correlation of that number of variables chosen at random with only 22 observations. The coefficients for hard winter and northern spring wheat, when corrected similarly for the number of independent variables, are reduced to 0.59 and 0.62, respectively. (For an exposition of the reason for correcting for the number of independent variables, see "The Application of the Theory of Error to Multiple and Curvilinear Correlation," by Mordecai Ezekiel, in the *Journal of the American Statistical Association*, March 1929, Supplement, XXIV, 99–101.) These coefficients are clearly significant, as the chance that such coefficients would be obtained from series chosen at random is less than one in 100. (R. A. Fisher, in his *Statistical Methods for Research Workers*, Table V (A), gives $P = 0.01$ for a correlation coefficient of 0.5897 when the number of degrees of freedom is 16.)

[3] Calculated, as in the case of the correlations cited above, with time included as an independent variable, using separate regressions on time for the pre-war and the post-war periods. The regression equation is

probably reveal still better bases for prediction.

Since elevator operators handling chiefly hard winter or northern spring wheat can readily avoid most of the potential losses from storage of hedged wheat and take full advantage of most of the potential gains—indeed, are almost forced by circumstances to follow this procedure—a simple average of changes in cash–future spreads must considerably understate the gains from storage, per bushel of wheat actually carried through from the post-harvest months to the spring months.

most conveniently stated in the form of separate equations for the two portions of the period, (1) pre-war, (2) post-war:

(1) $C = 1.55\,S + 0.25 - 0.502\,t$ (Origin for t, 1900)
(2) $C = 1.55\,S - 3.00 + 0.014\,t$ (Origin for t, 1920)

where C = Change in cash–future spread, July–September to March–May, in cents per bushel at the 1913 price level.

S = Spread in August between Chicago September and May futures, in cents per bushel at the 1913 price level.

t = Time, in years, with origins as noted above.

Two features of these results deserve special notice. The first is that during the pre-war period there was a progressive decrease in the change in cash–future spread accompanying a given spread between the September and the May futures. The average spread between the September and the May futures for the entire period was 5.50 cents. Such a spread tended in 1900 to be accompanied by a change between July–September and March–May of 8.77 cents in the cash–future spread; in 1910, to be accompanied by a change of only 3.75 cents. Regarding the slope of the trend in the post-war period as insignificant, the tendency during that period was for a 5.50 spread between the September and the May futures to be accompanied by a change in the cash–future spread of 5.52 cents. The reality of the pre-war trend is scarcely open to question, and study of the residuals indicates that it was approximately linear. It is impossible to say with confidence whether these facts indicate the existence, prior to the war, of a horizontal trend in the spread between the September and the May futures and a downward trend in the change in cash–future spread, as suggested by the illustrative data used above, or an upward trend in the spread between the September and the May futures and a horizontal trend in the change in cash–future spread. Inspection of the separate curves suggests that the latter is the case. The truth may lie somewhere between the two possibilities suggested.

The second feature of interest is that increasing the spread between the September and the May futures by 10 cents increases the expected change in the cash–future spread between July–September and March–May by 15.5 cents. In other words, a situation which causes the price of the September future in Chicago to be depressed 10 cents further below the price of the May future than it would have been in the same year under other conditions, causes the spread between cash wheat and the Chicago May future in the period July–September to be depressed 15.5 cents more, relative to the cash–future spread in the subsequent March–May period, than it would have been under the other conditions.

[1] The basis for this figure is discussed more fully on p. 20, below.

[2] For No. 2 Hard Winter wheat, the calculations show expected gross gains of 0.7 cent per bushel per month, or more, in 11 of the 22 years: the crop years beginning in 1899, 1900, 1901, 1906, 1907, 1912, 1913, 1923, 1924, 1926, and 1927. For No. 1 Northern Spring wheat, the calculations show expected gross gains of 0.7 cent per bushel per month, or more, in only 7 of the 22 years: 1899, 1900, 1901, 1902, 1907, 1912, and 1924.

Influence of Judgment

A simple calculation will give some idea of the effect of selection of years in which to store heavily on the gain per bushel of wheat stored. We may assume, for illustration, that since interest and insurance on stored wheat amounted on the average to about 0.7 cent per bushel per month at the 1913 price level,[1] a given dealer stores no wheat over long periods in years when the expected gross gains from storage are less than this amount and that in each of the remaining years he carries a fixed amount of wheat through the winter. Some of the years in which a gross gain of less than 0.7 cent a month was anticipated will turn out to be years in which a considerably greater gain would have been realized had wheat been stored. Some of the years in which a gross gain of over 0.7 cent a month was anticipated will actually show a loss after deduction of interest and insurance. But, taking the gains and losses as they came over the 15 pre-war and 7 post-war years under consideration, and basing the estimates of expected gain on volume of total stocks and size of crop, this procedure would have shown an average gross gain of 1.10 cents per month on each bushel of No. 2 Hard Winter wheat stored by a Kansas City elevator and 0.88 cent per month on each bushel of No. 1 Northern Spring wheat stored by a Minneapolis elevator.[2] These averages make a much better showing of profit from storage than the corresponding simple averages of 0.71 cent and 0.46 cent, respectively.

Dealers in red winter wheat may actually have been able to predict gains and losses from storage to some extent, even though the correlations cited above (p. 16) fail to indicate such a possibility, but dealers in the other two wheats were un-

doubtedly also able to predict gains and losses more accurately than these correlations indicate. In these circumstances, it appears reasonable to compare the simple average indicated gain per bushel from storage of red winter wheat, hedged, with the averages for the other two wheats arrived at by the selective process described above. The following showing of average gains per month, in cents per bushel at the 1913 price level, is made on this basis:

No. 2 Hard Winter wheat.....	1.10
No. 2 Red Winter wheat.....	1.21
No. 1 Northern Spring wheat.....	0.88

It would be a mistake to consider the above figures as highly accurate indications of actual average gross gains per bushel of wheat stored by the average dealer storing the specified classes and grades of wheat during the 22 years under consideration. In general, it is to be assumed that average gross gains from storage were higher than is indicated by the above figures. The average dealer probably forecasts prospective gains and losses more accurately than we have assumed that he could.[1]

The average dealer certainly carries much heavier stocks in the years of large prospective gains than in years of moderate prospective gains—the heavy stocks and large receipts from the large crops of such years make this inevitable—and so raises his average gain above that shown by these calculations. Even more important, the average dealer undoubtedly buys to better advantage in many years than we have here assumed; consideration of the last three years in which storage of No. 2 Hard Winter wheat showed prospects of being profitable shows, for example, that in 1924–25 the cash–future spread in July averaged —5.7 cents, while in the next two months it averaged —11.8 and —11.6 cents, respectively (all on the 1913 price level basis). By postponing purchases until August and September the wheat could have been obtained at an average spread of —11.7 cents instead of at the three-month average of —9.7 cents which we have used, and the gain from storage thereby increased 2.0 cents. In 1926–27 and 1927–28, spreads were much more favorable in July and August than in September. Wheat bought at the average spread in those two months would have showed gains from storage 1.1 cents larger in 1926–27 and 1.7 cents larger in 1927–28 than wheat bought at the average spread for the three months, the basis used in our calculations above.

With all their limitations, the figures tabulated above clearly give better indications of average gross gains from storage of the three specified classes and grades of wheat than the simple averages of changes in cash–future spreads (p. 13) and much better indications than the averages of gross price changes discussed in the first section of the present study. Probably the figures are fairly close to the facts they are intended to represent, and certainly they are the most trustworthy figures as yet available in the literature.

Probable Errors of the Averages

Averages of changes in cash–future spreads, like the averages of changes in cash prices discussed in the first section of the present study, may give an accurate statement of facts as observed over a certain period and still misrepresent in some degree the general tendency prevailing during the period. It would be desirable to know how far the averages shown in the above paragraphs may have been affected by special, more or less accidental, circumstances apart from the true general tendencies toward gains from storage during the period—in other words, to know within what limits the general tendencies may be said to lie. There is small point in attempt-

[1] The effect of better forecasting is interestingly illustrated by the results of using the spread between the Chicago September and May futures in August to forecast changes in the cash–future spread for No. 2 Hard Winter wheat at Kansas City. As noted above, the spread between the September and May futures gives a much better forecasting basis than the data on stocks and crop, as represented by the correlation coefficient $R = 0.892$ as compared with $R = 0.726$. Using this better basis for forecasting changes in spread, expected gross gains of 0.7 cent per bushel per month, or more, are indicated in all of the 11 years listed in the previous footnote except the crop year beginning in 1912, and in three additional years: 1908, 1910, and 1911. If an elevator had been filled in each of these 13 years, the average gross gain from change in cash–future spread would have been slightly less than if it had been filled in only the 11 years indicated by the poorer forecasting method—1.08 cents per bushel per month instead of 1.10 cents per bushel per month—but the total gains per bushel of storage capacity would have been 112 cents for the 13 years and only 97 cents for the 11 years.

ing such a calculation for the weighted averages for hard winter and for northern spring wheat, obtained as they were by a somewhat arbitrary method. The simple average for No. 2 Red Winter wheat has a standard error of 0.20 cent.[1] On the assumption that chances as small as one in 40 may be neglected, this indicates that the true general tendency to average gain from storage of No. 2 Red Winter wheat may possibly have been as large as 1.63 cents a month or may possibly have been as small as 0.79 cent a month.

Conclusions

The main conclusions following from the analysis presented in this section—the fact that the post-harvest depression of cash–future spreads, and therefore most, if not all, of the depression of cash prices, is a variable, changing greatly from year to year with changing conditions, and the fact that the average post-harvest depression does not measure average gross gains from storage—were summarized in the opening paragraphs of the section. There remain, however, several other conclusions which should be brought together here.

The amount of the post-harvest depression is shown, for No. 2 Hard Winter and for No. 1 Northern Spring wheat, at least, to depend in part on the total quantity of wheat remaining in storage in the United States from the previous year and in part on the size of the current year's crop. The post-harvest depression of No. 2 Hard Winter wheat was shown to be closely reflected in the spread between the September future and the May future in Chicago. It appears reasonable to assume that the spread between the same futures in Minneapolis would similarly reflect the post-harvest depression of No. 1 Northern Spring wheat. Likewise, the spread between St. Louis red winter futures, when quoted, would reflect the post-harvest depression of No. 2 Red Winter wheat. It may be supposed that the post-harvest depression shown by a particular wheat depends more on the quantity of that wheat remaining from the previous year than on the quantity of all wheat remaining, and that it depends also on a variety of factors affecting rate of movement from farms and on the current and expected volume of the export trade.

The averages, over 15 pre-war years and 7 post-war years, of changes in cash–future spreads between three post-harvest months and three spring months, were supplemented by estimates of possible average gross gains from storage of hedged wheat. While these estimates must be regarded as very rough approximations, they appear useful for comparative purposes and may be repeated here with the simple averages. The figures, in cents per bushel per month at the 1913 price level, are:

	Average change in cash–future spread	Estimated possible average gain from storage
No. 2 Hard Winter wheat at Kansas City.....	0.71	1.10
No. 2 Red Winter wheat at St. Louis.....	1.21	1.21
No. 1 Northern Spring wheat at Minneapolis..	0.46	0.88

III. APPARENT DEALERS' PROFITS FROM STORAGE

Since the figures finally arrived at in the last section appear to deserve acceptance as indicating, at least roughly, average dealers' gross profits per bushel per month from storage of hedged wheat of the three important classes and grades considered, interest naturally turns to a comparison of these figures with average costs of storage.

Costs of storage may be divided into two classes: (1) costs associated with the wheat, and (2) costs associated with the elevator space in which the wheat is stored. For the dealer owning or leasing elevators for his own use, costs in the first class are direct and closely proportional to the amount of wheat stored and to the time it is held, while costs in the second class are indirect or overhead costs, their total per month being practically the same whether the elevator is full or empty.

[1] It may be noted in passing that the standard errors of the simple average changes per month in cash–future spreads for No. 2 Hard Winter and for No. 1 Northern Spring wheat are only 0.14 cent and 0.11 cent, respectively.

The first class of costs is composed chiefly of interest and insurance, and may be roughly estimated at 0.7 cent per bushel per month, at the 1913 price level. The Federal Trade Commission has compiled data by six-month periods representative of interest rates for loans on hedged wheat stored in Chicago.[1] For the 15 years, July 1899 to June 1914, the average rate of interest is 5.27 per cent. Interest at this rate on dollar wheat would amount to 0.44 cent per bushel per month. Interest rates at St. Louis, and especially at Kansas City and at Minneapolis, probably averaged higher than at Chicago, as they have in recent years. The 22-year averages of prices of No. 2 Hard Winter wheat at Kansas City, No. 2 Red Winter wheat at St. Louis, and No. 1 Northern Spring wheat at Minneapolis, at the 1913 price level, is 92.7, 100.8 and 99.4 cents per bushel. At these prices, interest charges must have averaged very close to 0.5 cent per bushel per month at each of the three cities, possibly somewhat lower at Kansas City and probably somewhat higher at Minneapolis.

Insurance rates at Chicago are estimated by the Federal Trade Commission at 0.2 per cent per month, which, on dollar wheat, would amount to 0.2 cent per bushel per month.[2] Insurance rates on wheat in fireproof concrete elevators with modern facilities to guard against fire and explosion are much below this figure, as at Kansas City where the rate of insurance against fire, explosion, lightning, and tornado is only 0.04 cent per bushel per month. In earlier years at Kansas City, and even in recent years at St. Louis and Minneapolis, much wheat was stored in the older type of elevator where insurance rates were high. The Chicago figure of 0.2 cent per bushel per month may be taken as representative of the cost of insurance on much of the wheat stored during the 15 pre-war and 7 post-war years in Kansas City, St. Louis, and Minneapolis. Allowing 0.5 cent per bushel per month for interest and 0.2 cent per bushel per month for insurance on stored wheat, gives the total of 0.7 cent per bushel per month, stated above as the approximate total, at the 1913 price level, of costs associated with the wheat itself.

Costs of Storage Space

The costs which, for the dealer owning or leasing his own elevators, are indirect, are much more difficult to estimate on a bushel basis. They consist primarily of interest, depreciation, maintenance, insurance, and taxes on the bins used for storage. These annual costs, which may readily be approximated, must be expressed as costs per bushel of wheat stored. Few elevators store only wheat, and it is necessary to distribute the total storage cost among the several grains. It may be assumed that the distribution should be in proportion to the average quantity of each grain stored, or in other words, that the space cost per bushel per month of storage on all grains should be the same. A more difficult problem of distribution of costs arises in connection with the fact that much of the wheat carried in any year is held because of requirements of the merchandising program or for the sake of accumulating stocks of appropriate qualities for mixing. It has been noted above (p. 17) that in 11 years out of the 22 considered it appeared unreasonable to expect the returns from storage of No. 2 Hard Winter wheat to equal the cost of 0.7 cent per month for interest and insurance on the wheat; in 15 years out of the 22 considered it appeared unreasonable to expect the returns from storage of No. 1 Northern Spring wheat to equal the cost of 0.7 cent per month for interest and insurance on stored wheat. In none of these years, therefore, did it seem reasonable to accumulate wheat for the sake of profits from storage. In each of these years, however, large quantities of wheat were accumulated in the late summer or fall by elevators in Kansas City and in Minneapolis and carried for considerable periods. Some of the wheat so carried was probably stored in the belief that gains

[1] *Prices of Grain and Grain Futures* (Report .... on the Grain Trade, VI), 1924, p. 195.

[2] *Op. cit.*, p. 194. This is in close agreement with our statement, based on independent and more recent data, that "An average rate in Chicago is $1.80 per $100 per year" (see "Wheat under the Agricultural Marketing Act," WHEAT STUDIES, August 1929, V, 384): at this rate, insurance for a six-month period, figured at seven-tenths of the annual rate (see Federal Trade Commission report cited above, footnote, p. 194), would amount to 0.21 per cent per month.

on storage would accrue sufficient to cover interest and insurance and to contribute something toward the cost of the bin space, but it must be supposed that most of the No. 2 Hard Winter or No. 1 Northern Spring wheat carried in these years was held for the sake of merchandising and mixing profits expected to more than offset the anticipated storage losses. The losses, or occasional unexpected gains, on storage of such wheat clearly should not be included in calculating average gains from storage of wheat, but should be entered with the gains and losses from merchandising and mixing. It is not so clear how such grain should be treated in calculating the cost of storage of wheat. Should costs of storage per bushel be computed by distributing the total space costs over the total average quantity of grain in the elevator, or only over the grain held specifically for the sake of gains from storage? In other words, shall grain held for the sake of merchandising and mixing profits be made to carry its proportionate share of the elevator space costs or not?

From a practical accounting viewpoint, probably the only feasible method is to make no distinction between grain held for gains from storage and grain held for other purposes. Elevator records will seldom show for what purpose grain is held. There is much to be said for this method on theoretical grounds also. Because of the difficulty of distinguishing in practice between grain held for gains from storage and grain held for other purposes, the theoretical calculation of gains from storage made in the last section is perhaps more trustworthy than any calculation that could be made from actual accounting records, but for the sake of calculating costs of storage per bushel per month, records of the quantities of grain actually held are much to be preferred.

The calculation of average utilization of elevator storage capacity is necessarily laborious. The Federal Trade Commission attempted such a calculation for the calendar years 1919 and 1920 and arrived at an average of 38.1 per cent utilization of rated capacity for ten interior and five seaboard points.[1] This figure was obtained by dividing total average reported stocks of all grains by the rated average capacity of the elevators supposed to be reporting. The percentage utilization ran higher for the seaboard points than for the interior points, and the general average was somewhat too high because the stocks of grain reported covered some grain in elevators not included in the tabulation of elevator capacity. As a result, stocks at the highest point are shown as 129.7 per cent of capacity in Milwaukee, 151.1 per cent in New York, 156.2 per cent in Galveston, and 222.4 per cent in Indianapolis—all obviously impossible figures. The years 1919 and 1920 may be counted as years of unusually large stocks, since during most of the period the visible supply of wheat was at the highest, or next to the highest, figures recorded for the month up to that date. The average utilization of elevator capacity may be taken as under 35 per cent.

It must be recognized also that costs vary widely as between dealers. The portion of costs represented by interest, insurance, and depreciation on the investment in an elevator owned by a dealer varies according as the elevator was built in a period of high or of low construction costs. Where elevators are leased from railroads the terms have frequently been exceptionally favorable, so that costs of elevator space to a lessee have been considerably below costs to an owner.[2] Other things being constant, there must remain considerable variation between elevators in cost per bushel of

[1] *Terminal Grain Marketing*, p. 277.

[2] In 1920, the elevators owned by railroads and leased to dealers represented the following percentages of the total elevator capacity, apart from that operated by millers and converters: at Kansas City, 78 per cent; at Chicago, 43 per cent; at Duluth-Superior, 25 per cent; at St. Louis, 3.7 per cent; and at Minneapolis, 1.4 per cent; see data in *Terminal Grain Marketing* (Report of the Federal Trade Commission on the Grain Trade, III), 1922, pp. 288–89.

The Federal Trade Commission (*op. cit.*, chap. iii) cites several cases of highly favorable terms granted to lessees of railroad elevators and of rulings of the Interstate Commerce Commission (1908, 1911, and 1913) condemning nominal rentals and rental contracts obligating the lessee to make all shipments over the lessor railroad. It is stated that, as a result of protests from receivers and shippers of grain in Kansas City, in 1918 the Interstate Commerce Commission "recommended that certain leases be surrendered so as to provide the 'independent' receivers and shippers with the facilities necessary to operate under the existing conditions, and that the rentals of all leased houses be materially increased." The rentals were increased 40 per cent.

grain stored owing to variations in percentage utilization of the available space.

In the light of these facts, we may undertake to appraise roughly the range in costs of storage of wheat per bushel per month to different dealers. At the lower limit of the range stand a few dealers at terminal and transfer points in the Mississippi-Missouri Valley (excluding St. Louis and Minneapolis, however, where there are no large railroad elevators) who, during much of the 15 years prior to the war, leased railroad elevators at purely nominal rentals. Their costs for storage space may be roughly estimated at something like 0.1 or 0.2 cent per bushel per month on grain actually stored, making their total costs, including interest and insurance, something like 0.8 or 0.9 cent per bushel per month, at the 1913 price level. A more representative low cost figure may be based on the rentals of Kansas City railroad elevators as fixed in 1913. In that year, rentals were "arrived at for the 10 railroad elevators on the basis of 5 per cent of 'present valuation less an average estimated depreciation for 5 years'."[1] These rentals averaged 0.95 cent per bushel of rated capacity per year for the eight large railroad elevators at Kansas City.[2] Assuming 35 per cent utilization of the capacity, which appears liberal, the cost of storage space at these rentals would average 0.23 cent per bushel per month on the grain actually stored. This figure must be regarded as falling considerably below the average cost of space to even the most favorably situated dealers owning their own elevators, for the figure is arrived at on the basis of rentals which provide only a low interest return on the investment and make no provision for depreciation and insurance.[3]

If, on the valuation of the Kansas City elevators, as arrived at in 1913, one were to allow costs of 6 per cent interest and 3 per cent to cover depreciation, insurance, taxes, maintenance, and profit, a return of 1.71 cents per bushel of capacity per year would be necessary to cover the costs. At 35 per cent average utilization of space, this would represent a space cost of 0.41 cent per month per bushel of grain stored, and at 20 per cent utilization, a space cost of 0.71 cent per month per bushel of grain stored. Adding 0.7 cent for interest and insurance on stored wheat would give total costs of 1.11 and 1.41 cents per bushel per month, figures which are probably much closer than any given above to the actual costs of storage of wheat for dealers and millers operating their own elevators.

To arrive at a cost figure approximating the maximum of the range of dealers' storage costs, one may take the published rates for storage in public elevators in Chicago during the years immediately preceding the war. The price level at this time was at approximately the 1913 level, in terms of which the figures on gains from storage have been expressed. The charges for storage of wheat in public elevators in Chicago from December 1910 to December 1916 were one cent a bushel for the first ten days of storage, including elevation and loading out, and 1/30 cent a day, or approximately one cent a month, for subsequent storage.[4] The excess charge for the first ten days' storage may be assigned as a cost of merchandising rather than a cost of storage. The storage charge of one cent a month, plus interest and insurance at 0.7 cent a month, gives a total storage cost of 1.7 cents per bushel per month. The fact that very little wheat is held in public storage at the published rates[5] may be offered as evidence that the rates are much above the average cost of storage to dealers operating their own elevators. Such a conclusion is unwarranted, for it is not to be supposed that much wheat would be carried in public elevators by others than the elevator operators, even though the storage charges were below average costs to

[1] *Terminal Grain Marketing*, p. 102, footnote.

[2] Computed from data in *Terminal Grain Marketing*, pp. 102, 299–300.

[3] The calculated cost of space to the lessees should include certain costs in addition to the rental, but from the total rental should be deducted that portion which may be regarded as rental for the workhouse. These two items probably balance closely enough for present purposes.

[4] *Prices of Grain and Grain Futures*, p. 195, footnote.

[5] Large quantities of wheat are regularly stored in public elevators, but chiefly by the operators of the elevators, either openly or, where storage by the operator is prohibited, as in Chicago, through some subterfuge. See *Terminal Grain Marketing*, pp. 127–28 and 137–46.

the majority of private elevator operators. Two factors in particular operate against extensive use of public storage facilities by the public. First is the fact that an independent dealer utilizing such space must forego the profits of mixing, estimated by the Federal Trade Commission to average about 2 cents a bushel.[1] Second, and probably more important, is the fact that with the anticipated gains from storage varying widely from year to year (as shown in the previous section) a dealer cannot afford to place wheat in public elevators for long period storage in any but the years in which the prospective gains exceed the storage charge plus interest and insurance on the wheat, and in the years in which he could afford to place wheat in public storage he must expect to find the space largely monopolized by the operators of the public elevators themselves. In view of the circumstances surrounding the operation of public elevators and the determination of storage charges, it is not likely that the rates set are much in excess of what is generally believed to be a common cost of storage.

Conclusions

Briefly, then, it appears that over the 15 pre-war years and the 7 post-war years costs of storing wheat may have averaged, at the 1913 price level, as low as 0.8 cent per bushel per month for a few dealers and as high as 1.7 cents per bushel per month for some other dealers. The range for the majority of dealers and millers operating large elevators owned by themselves was probably in the neighborhood of 1.11 to 1.41 cents per bushel per month. Setting these costs against the estimated possible gross gain of 1.10 cents per bushel per month on storage of No. 2 Hard Winter wheat at Kansas City (see above, p. 18), it appears that at Kansas City and at other points where the possible gains from storage were similar, only dealers operating elevators leased on exceptionally favorable terms could have made a profit on the storage of wheat during the 22 years under review. The estimated average gain of 1.21 cents per bushel per month on No. 2 Red Winter wheat apparently would have shown a modest profit on storage for most dealers. As only two small elevators in St. Louis are owned by railroads,[2] there appears to have been no opportunity for large profits to dealers there in consequence of their operation of elevators leased from railroads on exceptionally favorable terms. The estimated average gain of 0.88 cent per bushel per month on storage of No. 1 Northern Spring wheat at Minneapolis would show a loss on storage of wheat on any of our calculations of cost except to dealers leasing elevators on exceptionally favorable terms, of which there appear to have been few or none in Minneapolis.[3]

When account is taken of the doubtful accuracy of the above figures on average gross gains from storage of wheat and on the range of storage costs, one conclusion only appears warranted, relative to profits from storage: during the 22 years under review, as a whole, gains from storage of hedged wheat of the three principal classes and grades in the terminal markets in which they are chiefly handled in the United States were certainly not greatly in excess of the costs of storage. The gains may indeed have been insufficient to yield ordinary profits, except as supplemented by the profits of concurrent merchandising and mixing operations.

If profits from storage are to be determined with much greater accuracy than the foregoing data give, resort must be had to the accounting records of representative dealers over a long period. Given such records, it is probable that one would be forced to abandon the attempt to determine profits from storage separately and to be content with data on profits of storage and of merchandising combined.

Facts generally available to the well-informed observer give a fair indication of the relative profitableness of different lines

[1] *Ibid.*, pp. 158–59.

[2] *Terminal Grain Marketing*, pp. 308–9. Mention should be made also of the large elevator owned by the Burlington Grain Elevator Company. This elevator, built in 1896, was in 1920 operated as a public elevator by the Burlington Grain Elevator Company, itself not a dealer. The record does not show whether the elevator has been so operated during the entire period since its construction.

[3] The Federal Trade Commission found only one small railroad elevator in Minneapolis, and in 1920, only one other elevator operated under lease.

of business. We know of no evidence that wheat dealers have been conspicuously prosperous as compared with other business men in the United States during the present century. The conclusion appears warranted that if gains from storage of wheat, as observed during the past 30 years, are to be judged excessive, it must be not on the ground that grain dealers have obtained excessive profits, but on the ground that another system of merchandising, including storage as one of its functions, would have been more efficient. The system of merchandising wheat prevailing in the United States during the past can probably be improved upon, but it is unsound to claim for any new method the advantage that it would gain for farmers the allegedly excessive profits of carrying wheat through from harvest time to spring. It is pertinent only to show that the new method would result in transferring the wheat from farmer to consumer at less total cost and with greater, or at least equal, incidental advantage to the community; or perhaps, if the interests of the farmer be considered paramount, to show that the wheat could be sold to the consumer at such a price as to yield a larger return to the farmer than under the existing method.

IV. POTENTIAL GAINS FROM FARM STORAGE

While the data presented on previous pages reveal as unfounded the allegation that dealers make exorbitant profits on the storage of wheat, they fail to indicate whether farmers might profit from storing wheat more extensively, had they the requisite financial resources. The gross gains from storage that fail, apparently, to cover costs of commercial storage, as ordinarily calculated, may be sufficient to cover the costs of farm storage, and to leave a modest margin of profit. Or it may be that the farmer, storing wheat unhedged, gains more from storage than the dealer storing wheat hedged.

To arrive at an estimate of possible gross gains from farm storage, it is necessary to return to the question of the average increase in cash prices. The change in the cash–future spread, which alone is significant for most dealers, is generally of little interest to farmers, since they do not hedge stored wheat.

Should Farmers Hedge?

It is pertinent to remark in passing, however, that farmers who produce much wheat might frequently gain by storing their wheat, hedged. In a year such as the present (1929–30), large gains from storage of hedged wheat are practically assured to anyone having good storage facilities. In September the price of the Chicago May future averaged 17 cents above the September future. Relationships between the corresponding futures in other markets were similar. In Minneapolis the spread between the September and the May futures during September averaged 13 cents; in Kansas City the corresponding average was close to 16 cents. A farmer who considered current cash prices satisfactory and who had good bins might have sold May wheat instead of selling his cash wheat and carried the cash wheat through the winter. He might reasonably count on selling the cash wheat in May at as favorable a price, relative to the then ruling price of the May future, as that obtaining in September relative to the September future.[1] He could thus reasonably anticipate a return of 13 to 17 cents a bushel on the wheat stored from September to May. The situation this year presents an extreme illustration, but years in which farmers could reasonably count on good returns from following such a plan are not infrequent.

For the small producer, such a plan is not feasible, for the smallest unit in which wheat can be hedged is 1,000 bushels. For small farmers, co-operative action would be necessary. It must be noted also that the plan could not be adopted by a farmer under financial pressure to sell, for he would receive no cash until the actual wheat was sold and in the interval would have to maintain the customary margin on the hedge sold. This margin would be at least 10 cents a bushel and would have to

[1] Of this he could not be assured, but the chances of gain in premiums seem to equal the chances of loss.

be added to if and as the price of the future rose above the price at which it was sold.

Tendencies in Futures Prices

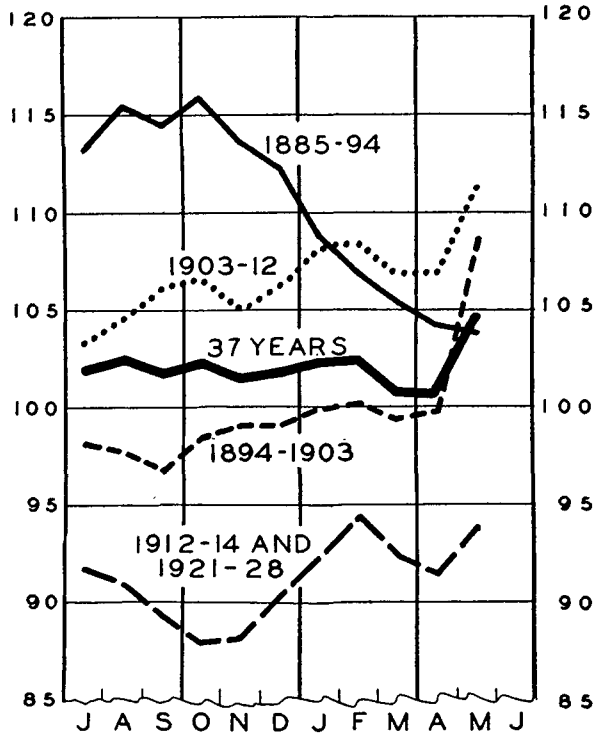
Returning to the problem of the farmer storing wheat unhedged, we have to consider in what degree his gross gains from storage may differ from those of the dealer storing hedged wheat. Apart from differences arising from better or poorer judgment as to the years in which to store heavily, the only difference in gains arises from the fact that the farmer, storing wheat unhedged, stands to gain from any tendency of the price of the May future to rise from fall to spring and to lose from any tendency of the future to decline from fall to spring. It is commonly alleged that futures prices as well as cash prices are usually depressed in the post-harvest period.

Averages by months of the price of the Chicago May future over the 22 years, 1899–1900 to 1913–14 and 1921–22 to 1927–28, show a rise of over 3 cents from July or August to May and a rise of 4.4 cents from November to May. (See Appendix Table I.) It is this average seasonal change that accounts for the larger rise from fall to spring in the cash prices than in the cash–future spreads. (See also Appendix Table I and charts on pp. 4 and 11, above.) The average changes in futures prices, like the average changes in cash prices, have large probable errors. Such small average changes as are observed in the price of the Chicago May future offer no strong statistical evidence of a general tendency to rise from fall to spring.

In dealing with cash prices, we were restricted to the period since 1899, because the available weighted averages of cash prices begin with 1899–1900. The average seasonal change of the Chicago May future can readily be calculated for a longer series of years. The averages by months for the 37 years, 1884–85 to 1913–14 and 1921–22 to 1927–28, covering a much longer period,[1] deserve more confidence as an indication of the general seasonal tendency of the price of the Chicago May future than the 22-year averages referred to above. These averages, given in Appendix Table I, and shown graphically by the heavy solid line in Chart 5, show very little change from July to February. The March and April averages are a little over 1.5 cents under the February average and the May average slightly over 2 cents above, but even these differences give little evidence of any general seasonal tendency.

Chart 5.—Averages by Months of Prices of the Chicago May Wheat Future*

(Cents per bushel at 1913 price level)



* Data from Appendix Table I. Averages by months over the 37-year period 1884–85 to 1913–14 and 1921–22 to 1927–28 reveal no tendency toward a post-harvest depression in the price of the Chicago May future. Averages for some shorter periods suggest a tendency to post-harvest depression, while averages for other periods suggest quite a different tendency.

Averages by months for four subperiods of nine years each are also shown in Appendix Table I and in Chart 5. Each of the sets of nine-year averages suggests the existence of a seasonal tendency in the price of the Chicago May future, but each suggests a different seasonal tendency.

[1] The years covered represent the full period included in the compilation in our office files, except for the war years, which are omitted as clearly unrepresentative. To carry the averages back to July it has been necessary in several cases to take hypothetical prices of the May future, basing them on the December, October, or September future; see note to Appendix Table II.

There is, furthermore, no regular change from one apparent seasonal tendency to the next, such as might be accounted for by progressive changes in the time of heavy marketing of wheat or progressive changes in other conditions in the trade. The curves for the four subperiods, considered together, reinforce the conclusion dictated by a consideration of the probable errors of the averages, that no significance can safely be attached to the variations in any of the curves, including that for the entire 37 years, and that there is no evidence of any general tendency for the price of the Chicago May future to be depressed or raised at any season rather than at any other. True, all the curves show a decline from February to March and all but one a rise from April to May. These may reflect true general tendencies, but if so, they are too small to be of much significance. Certainly there is no evidence in the data for the longer period of 37 years to suggest the existence of a tendency toward a post-harvest depression in the price of the Chicago May wheat future.

Reasonable Expectations

The statistical evidence that there is no tendency toward a significant post-harvest depression in the price of the Chicago May future is in line with what should be expected from the nature of the futures market. Traders in futures generally have no interest in seeing prices of futures depressed at one season of the year rather than at another. Dealers in cash wheat, who are also traders in futures because of their custom of hedging purchases, might be supposed to be interested in seeing futures prices high during the period of heavy purchasing in order to make their hedging sales to the best advantage, were it not that a rise in futures prices would normally carry cash prices up by an equal amount and thus leave no net advantage to them. As for other traders in futures, they are at liberty to trade in any quantity of wheat their judgment may suggest and their finances permit at any season of the year, and are equally free to buy or to sell at any time. They are interested in having prices low at some time and high at another time, since price movements are requisite for profits, but it is immaterial to them at what season of the year the low level comes and at what season of the year the high level. The great number of traders operating and their wide distribution forbid any assumption of general joint action. If a single large trader or a group of traders operating in unison is able to manipulate prices, that trader or group of traders would certainly not choose the same season of each year for depressing prices, for any such regularity in price movement would attract other traders to take advantage of the movement; the other traders would gain a large share of the advantage of the manipulation, leaving the manipulator to stand all the expense of the manipulation and even increasing it. Neither special interests of futures traders in general nor special interests of powerful individual traders or groups of traders are such as to suggest a tendency to depress futures prices at a particular season.

Another line of reasoning offers a more valid basis for expecting a post-harvest depression of futures prices. The period of heavy farm marketing of wheat brings a large volume of hedging sales on the market. Many have supposed that futures prices must be depressed during the period of heavy farm marketing by these hedging sales. The very fact that this supposition exists leads many futures traders to favor buying rather than selling during this period. In a futures market as broad as that for wheat it is easily possible that a general belief that the period of heavy crop movement is the time for buying of futures should cause an increase in buying greater than the increase in hedging sales and so should produce a general tendency toward a rise in futures prices at this season. When due consideration is given the character of the futures market, the presence of heavy hedging sales of futures in the immediate post-harvest months, generally known as it is, gives no valid reason for supposing that futures prices are regularly depressed in that period.

These facts lead to the conclusion that the failure of the farmer to hedge his stored wheat neither raises nor lowers his average gross gains from storage, as compared with the gains of dealers. By not hedging, he avoids a certain additional expense. At the

same time he foregoes such insurance as hedging would afford.[1] If farmers gain more or less from storage of wheat than dealers, it is because they choose better or worse the years in which to store heavily. Dealers may be supposed better acquainted with the facts likely to determine gain or loss, but since the large gains come in years of large supplies, both farmers and dealers naturally store more heavily in the years of large gains. Farmers' average gross gains from storage may be assumed, provisionally, to differ little from dealers' average gross gains. Certainly, if farmers gain much more or much less than dealers, it is because of judgment or circumstances affecting their choice of the years in which to store heavily and not because of any regular tendency to a seasonal variation in futures prices.[2]

Implications Respecting Cash Prices

The conclusion that there is no tendency to a post-harvest depression of futures prices has an important bearing on the problem of measuring the average tendency to post-harvest depression of cash prices. The discovery that the tendency to post-harvest depression is not a constant, but a variable, changing from year to year with changing conditions, and that a simple average of the various tendencies may not be taken as an indication of average gains from storage leaves relatively little significance attaching to measures of average tendency to post-harvest depression of cash wheat prices, but there remains a certain interest in the problem which warrants a brief digression at this point to consider the implications of facts brought out in the examination of cash-future spreads and of futures prices.

If there is no general tendency toward a post-harvest depression of the price of the Chicago May future, it follows that the total average tendency toward post-harvest depression of cash prices is reflected in the post-harvest depression of the cash-future spread. There is a marked advantage in using the measures of depression derived from the cash-future spreads rather than the measures derived directly from cash prices; because of their smaller probable errors they provide more trustworthy indications of the general average of the tendencies. Whereas the standard errors of the averages of cash price changes from July to May or from November to July for No. 2 Hard Winter, No. 2 Red Winter, and No. 1 Northern Spring wheat were found to be 0.24, 0.22, and 0.22 cent per month, respectively,[3] the standard errors of the average changes in cash-future spreads were found to be only 0.14, 0.20, and 0.11 cent per month, respectively;[4] for No. 2 Hard Winter and No. 1 Northern Spring wheat the averages based on changes in cash-future spreads are subject to only about one-half the error of the averages based on changes in cash prices. The smaller influence of chance factors in the averages based on cash-future spreads is reflected in the greater regularity of the curves shown in Chart 3 (p. 11) than in the curves shown in Chart 1 (p. 4). The fact that the 22-year averages show a greater rise in cash prices than in cash-future spreads we have already noted as attributable to the fact

[1] It must be understood that for the farmer hedging has a very different significance than for the dealer. When the farmer sows his crop—indeed, when he undertakes farming as an occupation—he subjects himself inevitably to the risks of price fluctuations. Selling futures at harvest on grain to be stored, which we suggest above, may be advisable at times, but does not relieve the farmer of risks of price fluctuations; it merely provides a means of selling at the price level prevailing in the fall when he (wisely or unwisely) judges that level to be favorable, and at the same time storing the wheat and earning the profits of storing.

[2] This conclusion is predicated on the assumption that the Chicago May future, showing no regular upward or downward tendency from fall to spring, shows also no tendency for the years in which it does decline from fall to spring to be years of large (or small) farm storage, and vice versa. Comparison of the data on March 1 farm stocks of wheat and changes in the price of the Chicago May future from September to March (see Appendix Table X) suggest the existence of a slight tendency for the Chicago May future to decline between September and March in the years of large March 1 farm stocks, and vice versa. Because of this tendency, the average change in the Chicago May future per bushel of wheat carried on farms to March 1 (the average of the changes weighted by March 1 stocks) was 0.6 cent, or 0.1 cent per month, less, at the 1913 price level, than the simple arithmetic average of the changes in price of the Chicago May future from September to March. The effect of the apparent greater tendency toward decline of the Chicago May future in years of large farm stocks than in years of small farm stocks is therefore too small to call for further consideration.

[3] Standard errors in tabulation above, p. 8, reduced to a monthly basis.

[4] See text and footnote above, p. 19.

that for these particular years the averages for prices of the Chicago May future show a seasonal rise, but one which is a peculiarity of that particular group of years and not representative of a general tendency. On all counts, then, it appears that if we are correct in the judgment that there is no general tendency toward a post-harvest depression of the price of the Chicago May future, the average tendency to seasonal change in cash prices is most reliably reflected in the changes in cash-future spreads, as shown in Chart 3 and in Appendix Table I. For the purpose of interpreting changes in cash-future spreads in terms of changes in cash prices, the data in the second half of Appendix Table I will be found most convenient.

The conclusion that there is no general tendency toward a post-harvest depression of the price of the Chicago May future has an important bearing also on the more practical problems involved in study of the changes from year to year in the tendencies to post-harvest depression of cash prices. We have shown that the tendency to post-harvest depression in cash-future spreads varies greatly from year to year with changing conditions. If there is no tendency to post-harvest depression in futures prices, the variations in post-harvest depression of cash-future spreads reflect also identical variations in post-harvest depression of cash prices. We have not shown, however, that there is never any tendency to post-harvest depression of the price of the Chicago May future, but merely that there is no *general* tendency of the sort. Other studies which we have in progress have revealed the possible existence of tendencies for the price of the Chicago May future to rise from fall to spring under certain conditions, recognizable in advance, and to decline from fall to spring under other conditions, also recognizable in advance. It is questionable, however, whether these tendencies to rise or to decline, if shown to be real, should be ascribed to post-harvest depressions and to post-harvest elevations in the price of the Chicago May future. They represent price changes not anticipated by wheat traders generally. The post-harvest depression of the cash-future spread, on the contrary, is well recognized and the subsequent rise generally anticipated by traders. The only part of the change in cash prices from post-harvest to pre-harvest months which is generally anticipated is that incident to the rise of the cash-future spread. If the variations in post-harvest depression of cash prices from year to year are to be studied and discussed, it appears more reasonable to measure the post-harvest depression in each year by the portion of the subsequent price change which was largely anticipated at the time — namely, the change in the cash-future spread—than by the total price change, in which is included a part, equal to the change in price of the future, which was not generally anticipated. In the light of these facts the change in the cash-future spread appears to offer the best available measure, year by year, of the post-harvest depression of cash prices.

Costs of Farm Storage

The primary purpose of the present study is to indicate, as accurately as available data permit, the nature and magnitude of the post-harvest depression of wheat prices and the possible gross gains, to dealers and to farmers, from storage of wheat. The interest attaching to a comparison of gross gains from storage with costs of storage, however, calls for some consideration of costs of farm storage as well as costs of commercial storage.

The average cost of farm storage of wheat is even more difficult to estimate from available data than the cost of commercial storage, and is perhaps more variable. We know of no adequate published treatment of the costs of farm storage. It seems clear, however, that the cost of storage of wheat on the majority of farms is much below the cost of commercial storage. The items of interest and insurance to be charged on the storage are commonly supposed to be smaller for farm storage than for commercial storage because the farm price is always much below the terminal price. As regards interest, however, it is by no means clear that the farmer has the advantage, for he is not often able to obtain loans at as favorable rates as the dealer storing hedged wheat. Nor is it clear that the charge for insurance should be smaller on

the farm. Such a charge should be included, even though no insurance be carried, for the risk remains. Lacking data on insurance rates on wheat in farm storage, we can only call attention to the possibility of a greater risk from fire under conditions of farm storage than under conditions in modern terminal elevators, which would more than offset the advantage of the lower price at which the wheat is valued at the farm. The item of interest and insurance to be charged on the wheat stored must be close to 0.7 cent a bushel (at the 1913 price level) for farm storage as well as for commercial storage.

The charge for storage space on the farm, however, should probably be much less than the charge for storage space in commercial elevators. In many cases, no charge for storage space should be made. Farmers who are located at some distance from market cannot afford to haul the grain to the local elevator while threshing is in progress, and must provide adequate bin space on the farm to receive the entire crop.[1] Few farmers can do without bin space sufficient for a considerable fraction of the normal crop. No extra cost for the space is incurred when it is kept full or partly full during the winter.

Bins for such temporary storage do not need to be vermin-proof, however, and if they are used for storage over long periods, losses from rats, mice, and weevils may be heavy. Such losses must be added to the costs of storage. If bins are constructed to give adequate protection for long-period storage, the excess of interest, insurance, and depreciation over the corresponding figures for bins adequate for temporary storage must be charged as one of the cost items for long-period storage. This fraction of the total interest, insurance, and depreciation on storage space—or the alternative loss occasioned by vermin when bins unsuited to long-period storage are used for that purpose—is the only charge for space ordinarily to be made against farm-stored grain. It appears safe to assume that this cost is much below the cost of commercial storage space.

[1] R. M. Green states: "In answer to the question, 'How close to the railroad station would a farmer have to be to make hauling direct from the threshing machine possible and economical?' the majority of the farmers replied that one would have to be within 3 to 4.5 miles of their station. The average was 3.78 miles. . . . . The average [area within this distance of an elevator station] for the state is 38 per cent . . . . only a fraction of the wheat within this territory can actually be delivered direct from the machine because of the limited storage and handling facilities of the local elevators. . . . . To indicate what was actually done, instead of what might be done, data were secured showing the number of bushels of wheat actually sold direct from the machine. . . . . A record of 1,140,942 bushels of wheat showed . . . . 17.2 per cent, sold direct from the machine."—*Farm Storage as a Factor in the Marketing of Kansas Wheat* (Kansas Agricultural Experiment Station Bulletin 229), November 1922, pp. 18–22.

Conclusions

Although farmers storing wheat unhedged, as is customary, gain or lose from the changes in cash prices rather than from the changes in cash–future spreads, which determine dealers' gross gains or losses, it appears that the gross gains from storage open to farmers are about the same as the gross gains open to dealers. There appears to be no tendency to a post-harvest depression, or to any other regular seasonal movement, in the price of the Chicago May wheat future.

If the experience of the 22 years, 1899–1900 to 1913–14 and 1921–22 to 1927–28, may be regarded as representative of what may be expected generally, it appears that storage of the same amount of wheat each year from the three-month period July–September, or for spring wheat, September–November, to the three-month period March–May should yield gross gains averaging for No. 2 Hard Winter wheat, No. 2 Red Winter wheat, and No. 1 Northern Spring wheat, respectively, about 0.7, 1.2, and 0.5 cents per bushel per month, at the 1913 price level. By exercise of moderately good judgment as to the years in which to store, the gains on storage of hard winter and northern spring wheat, at least, may be raised to something like 1.1 cents and 0.9 cent per bushel per month, respectively, possibly more. To judge the gains to be expected with prices at their present level, all the above figures may be increased about 50 per cent.

In years in which excessive stocks in terminal markets and heavy movement of cash wheat, or other factors, result in large discounts of cash prices relative to futures prices, there is unusual opportunity for

profit from storage of wheat on farms. If the farmer regards the level of wheat prices in the late summer or fall as favorable for sales at that time, however, he must forego the gains from storage unless he makes use of the futures market for hedging. By storing his wheat hedged he might take advantage of a fall price level which he considers favorable for sale of the wheat and at the same time keep the wheat on the farm and reap the relatively certain gains from storage.

Among the costs of farm storage must be included a charge for interest and insurance on the stored wheat amounting to about 0.7 cent per bushel per month at the 1913 price level, though of course varying with circumstances. To this must be added a charge for storage space, but the latter should usually include only interest, insurance, and depreciation figured on the excess cost of bins adequate for long-period storage as compared with bins adequate for temporary storage.

These data indicate that under a policy of storing the same amount of wheat each year, even farm storage, with its relatively low costs, may be expected to prove unprofitable for both No. 2 Hard Winter and No. 1 Northern Spring wheat. They suggest, however, that with intelligent selection of the years in which to store heavily, farm storage should return a modest profit.

The foregoing conclusions, despite the qualifications with which it has been necessary to surround them because of inadequacies in the data, round out fairly well the body of information necessary to judge the reasonableness of the post-harvest depression of wheat prices. The depression varies greatly from year to year. In some years the depression is large, but much of the profit from storage in such years must go to cover the cost of maintaining necessarily unused storage space in other years and the actual losses in certain years on storage of such wheat as is carried. The possible gains from storage accruing as a result of the post-harvest depression of prices of the three principal classes and grades of wheat in the three principal United States markets for those wheats during 15 pre-war and 7 post-war years appear to have been less than the costs to most dealers for storage in terminal markets. If it be granted that large quantities of wheat should sometimes be stored by dealers in terminal markets, and that dealers should not be called upon to sustain a loss on such storage, the post-harvest depression of wheat prices, as observed during those 22 years, cannot be adjudged excessive.

It may be that the post-harvest depression of wheat prices over those years averaged slightly higher than would have been necessary if farmers had been willing and able to store more of the wheat in years of over-abundant supplies. Possibly the development of better judgment on the part of farmers as to the conditions under which it is wise to store wheat in large quantities; the provision of somewhat better farm storage facilities and perhaps of the necessary credit; and education of farmers in the advantages, under certain conditions, of storing wheat hedged, together with provision of convenient facilities therefor, might render unnecessary quite such large post-harvest depressions of wheat prices as have been observed in past years. Such a program might well be undertaken purely for the sake of increasing the profit of wheat farmers. If it resulted also in decreasing the average post-harvest depression of wheat prices, the outcome would demonstrate, not that the post-harvest depression in past years was excessive under the circumstances, but that reorganization of the marketing and storage system would permit of a smaller post-harvest depression.

This study is the work of Holbrook Working with the assistance of Adelaide M. Hobe

APPENDIX

TABLE I.—SEASONAL VARIATIONS INDICATED BY MONTHLY AVERAGES OF VARIOUS WHEAT PRICE SERIES, 22 YEARS, JULY 1899 TO JULY 1914 AND JULY 1921 TO JULY 1928, AND BY PRICES OF CHICAGO MAY FUTURE OVER OTHER PERIODS*

A. AVERAGES BY MONTHS

(Cents per bushel at 1913 price level)

Price series	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Cash wheat[a]													
No. 2 Hard....	88.8	88.0	89.2	90.9	90.5	92.1	94.6	94.9	94.6	94.9	97.9	95.8	89.6
No. 2 Red.....	92.7	92.8	96.4	99.4	98.2	101.3	104.9	105.3	104.3	104.7	106.4	103.1	94.3
No. 1 Northern	103.1	99.0	96.2	96.6	95.1	97.3	100.0	100.7	99.5	99.5	103.4	102.8	103.5
Cash–Future spread[b]													
No. 2 Hard....	—8.2	—8.8	—7.5	—5.4	—5.2	—5.0	—4.2	—4.6	—3.1	—2.2	—2.2		
No. 2 Red.....	—4.3	—4.0	— .3	+3.1	+2.5	+4.2	+6.1	+5.8	+6.6	+7.6	+6.3		
No. 1 Northern	+6.1	+2.2	— .5	+ .3	— .6	+ .2	+1.2	+1.2	+1.8	+2.4	+3.3		
Chicago May future[c]													
22 years[d]	97.0	96.8	96.7	96.3	95.7	97.1	98.8	99.5	97.7	97.1	100.1		
37 years[e]	101.9	102.4	101.8	102.2	101.4	101.8	102.3	102.4	100.8	100.6	104.5		
1st 9 years[f] ...	113.2	115.4	114.5	115.9	113.6	112.2	108.8	106.9	105.3	104.2	103.9		
2d 9 years[f]....	98.1	97.8	96.9	98.4	99.0	99.0	99.9	100.1	99.2	99.8	108.6		
3d 9 years[f]....	103.2	104.5	106.1	106.5	105.0	106.1	108.0	108.3	106.8	106.7	111.2		
4th 9 years[f] ...	91.8	91.0	89.3	88.0	88.2	90.4	92.4	94.3	92.3	91.5	93.9		

B. DEVIATIONS OF MONTHLY AVERAGES FROM DECEMBER AVERAGE

(Cents per bushel at 1913 price level)

Price series	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Cash wheat													
No. 2 Hard....	—3.3	—4.1	—2.9	—1.2	—1.6	0	+2.5	+2.8	+2.5	+2.8	+5.8	+3.7	—2.5
No. 2 Red.....	—8.6	—8.5	—4.9	—1.9	—3.1	0	+3.6	+4.0	+3.0	+3.4	+5.1	+1.8	—7.0
No. 1 Northern	+5.8	+1.7	—1.1	—0.7	—2.2	0	+2.7	+3.4	+2.2	+2.2	+6.1	+5.5	+6.2
Cash–Future spread													
No. 2 Hard....	—3.2	—3.8	—2.5	—0.4	—0.2	0	+0.8	+0.4	+1.9	+2.8	+2.8		
No. 2 Red.....	—8.5	—8.2	—4.5	—1.1	—1.7	0	+1.9	+1.6	+2.4	+3.4	+2.1		
No. 1 Northern	+5.9	+2.0	—0.7	+0.1	—0.8	0	+1.0	+1.0	+1.6	+2.2	+3.1		
Chicago May future													
22 years[d]	—0.1	—0.3	—0.4	—0.8	—1.4	0	+1.7	+2.4	+0.6	0.0	+3.0		
37 years[e]	+0.1	+0.6	0.0	+0.4	—0.4	0	+0.5	+0.6	—1.0	—1.2	+2.7		
1st 9 years[f] ...	+1.0	+3.2	+2.3	+3.7	+1.4	0	—3.4	—5.3	—6.9	—8.0	—8.3		
2d 9 years[f]....	—0.9	—1.2	—2.1	—0.6	0.0	0	+0.9	+1.1	+0.2	+0.8	+9.6		
3d 9 years[f]....	—2.9	—1.6	0.0	+0.4	—1.1	0	+1.9	+2.2	+0.7	+0.6	+5.1		
4th 9 years[f] ...	+1.4	+0.6	—1.1	—2.4	—2.2	0	+2.0	+3.9	+1.9	+1.1	+3.5		

* All the averages are based on deflated prices; the average price for each month from July to July for the cash wheats price series and for each month from July to May for the other price series was divided by the average Bureau of Labor Statistics wholesale price index number for the corresponding July–June crop years. By this method the prices in years of high price level are given equal weighting with the prices in years of low price level, the data are put on a 1913 price level basis, and yet the trend of the averages through the year is *not* corrected for an assumed relationship with the trend of the wholesale price index number; see text and footnote 2, p. 3. The wholesale price index numbers for the years 1899–1900 to 1913–14 and 1921–22 to 1927–28 are shown in Table X. For earlier years the Bureau of Labor Statistics index number was used, supplemented by Snider's quarterly index as published in the *Review of Economic Statistics*, Vol. 6, p. 107, April 1924.

[a] Computed from U.S. Department of Agriculture monthly weighted average prices at Kansas City, St. Louis, and Minneapolis, respectively; see notes on Tables III, IV, and V.

[b] Averages of data in Tables VI, VII, and VIII, respectively.

[c] Computed from data in Table II.

[d] Averages for the 22 years used for the previous six series, namely, 1899–1900 to 1913–14 and 1921–22 to 1927–28.

[e] Averages for the 37 years, 1884–85 and 1913–14 and 1921–22 to 1927–28.

[f] Averages for the successive nine-year periods 1885–86 to 1893–94, 1894–95 to 1902–03, 1903–04 to 1911–12, and 1912–13, 1913–14 and 1921–22 to 1927–28.

TABLE II.—AVERAGE PRICES OF THE CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1884 TO MAY 1914 AND JULY 1921 TO MAY 1929*

(Cents per bushel)

Crop year, July-June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1884-85	94.8	90.5	87.7	85.0	81.6	79.1	86.0	83.0	80.6	85.6	88.2
1885-86	102.6	98.7	93.4	97.1	95.2	91.9	86.4	85.0	83.7	78.6	75.7
1886-87	89.8	89.0	86.0	81.8	81.5	85.4	85.2	81.0	81.1	83.4	85.5
1887-88	83.1	80.1	78.6	78.4	80.5	84.5	83.6	81.1	78.8	79.2	84.8
1888-89	86.7	92.6	97.9	114.1	112.8	108.6	102.2	106.6	100.2	87.8	82.1
1889-90	83.9	82.4	83.3	85.0	84.4	83.0	80.7	78.0	79.6	85.0	94.3
1890-91	94.6	108.5	106.4	107.9	102.5	99.2	96.4	97.9	101.5	107.1	103.9
1891-92	93.6	104.7	105.4	103.4	101.5	97.6	92.1	91.4	86.6	81.0	82.6
1892-93	85.1	84.8	81.6	80.6	78.6	77.9	79.6	77.7	77.3	77.0	72.5
1893-94	81.3	75.8	77.8	73.3	69.0	67.3	65.3	60.5	59.0	60.6	56.2
1894-95	64.8	62.9	60.9	58.1	59.8	58.9	57.2	53.4	55.4	57.1	70.7
1895-96	75.0	71.4	63.5	64.6	61.6	59.8	61.9	66.4	64.0	64.8	60.7
1896-97	63.0	64.1	64.8	75.6	81.9	81.1	79.9	75.4	74.2	70.6	72.2
1897-98	74.3	87.0	93.5	91.0	91.2	92.3	92.2	99.6	104.7	111.4	153.2
1898-99	70.1	65.6	64.2	66.3	66.5	67.6	72.0	73.3	70.4	72.6	71.6
1899-00	76.8	75.8	74.6	75.1	71.8	69.6	67.7	67.4	66.3	66.4	65.5
1900-01	83.6	79.6	80.5	78.8	75.6	73.4	76.7	75.5	75.9	71.7	73.0
1901-02	73.0	76.7	74.4	73.5	75.8	80.6	80.4	77.7	74.8	73.0	74.2
1902-03	75.7	69.7	70.1	73.1	75.2	76.8	78.1	78.1	74.5	75.7	78.0
1903-04	79.3	83.5	82.8	79.0	78.3	82.0	88.6	98.4	95.3	91.4	93.6
1904-05	87.8	104.4	112.5	112.0	111.5	111.7	115.5	117.8	113.5	108.6	95.8
1905-06	89.0	86.6	86.0	87.4	88.6	88.2	87.6	83.2	77.8	79.1	82.6
1906-07	83.2	78.4	77.8	78.6	78.4	78.4	76.8	78.4	76.3	77.8	93.5
1907-08	102.5	99.5	105.8	108.2	102.1	103.4	102.9	95.2	96.0	93.0	102.8
1908-09	96.2	99.6	101.9	103.0	106.6	107.3	107.0	113.0	116.4	124.3	129.5
1909-10	109.4	100.2	100.3	104.8	104.6	110.7	111.8	112.0	113.3	109.9	110.7
1910-11	109.3	109.2	105.6	101.2	96.1	96.2	100.0	93.1	89.6	88.7	95.9
1911-12	96.7	100.9	102.8	104.8	100.6	98.4	100.6	102.0	103.0	108.5	115.0
1912-13	103.5	97.0	95.5	96.8	92.4	90.6	93.1	93.2	90.2	91.6	90.5
1913-14	96.6	95.2	95.1	89.8	90.6	91.3	92.5	94.0	93.3	91.6	96.4
1921-22	130.4	126.6	132.2	115.0	110.0	114.4	112.8	133.8	135.4	137.9	139.0
1922-23	118.4	109.6	108.0	110.7	115.4	121.8	118.6	119.9	120.0	124.0	118.7
1923-24	107.6	109.4	109.9	111.8	108.8	108.6	108.6	111.0	106.5	102.4	104.9
1924-25	128.8	137.2	137.9	150.9	158.3	168.8	188.9	189.4	174.8	150.0	167.1
1925-26	155.4	162.6	153.4	141.8	150.9	166.8	174.4	168.9	159.6	162.2	160.4
1926-27	149.9	145.9	141.2	145.5	141.8	139.8	139.6	140.9	137.8	133.8	143.7
1927-28	149.3	149.5	137.3	133.4	133.2	131.3	130.9	131.4	138.9	151.4	154.4
1928-29	141.0	122.6	122.6	123.6	123.4	121.6	122.1	130.2	126.1	117.8	102.1

* Based on weekly averages of daily highs and lows compiled from *Annual Reports* of the Chicago Board of Trade and from the Chicago *Daily Trade Bulletin*, the monthly averages being obtained by averaging the figures for the four calendar weeks (Monday to Saturday) falling entirely or chiefly within the month. This method of obtaining the monthly averages, adopted because of the form of the data previously compiled, was found, on comparison for a number of sample months, to yield averages differing from the averages of highs and lows for all days of the month by not more than 0.2 or 0.3 cent. When the May future was not quoted regularly, as has occurred frequently in July and sometimes in August, figures for the above table were obtained by taking the quotations for the December future, or occasionally for the October or the September future, and raising them by the premium shown by the May future when regular quotations began. This procedure was necessary for one or more weeks in July in each year except 1887, 1889, 1891, 1902–11, 1924, and 1925, and for one or more weeks in August in 1884, 1892, 1893, 1900, 1921, and 1927. Because of the relative stability of spreads between these futures, the figures thus obtained may be regarded as seldom, if ever, differing more than 1 or 2 cents from the averages that would have been obtained if the May future had been quoted throughout.

TABLE III.—CASH–FUTURE SPREAD, NO. 2 HARD WINTER WHEAT AT KANSAS CITY AND CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1899 TO MAY 1914 AND JULY 1921 TO MAY 1928*

(*Cents per bushel*)

Crop year, July–June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1899–00	—10.8	—10.8	— 9.6	—10.1	— 8.8	— 5.6	— 4.7	— 3.4	—2.3	— 2.4	—3.5
1900–01	—14.6	—13.6	—13.5	—10.8	— 8.6	— 7.4	— 8.7	— 7.5	—6.9	— 1.7	—3.0
1901–02	—10.0	— 9.7	— 8.4	— 7.5	— 6.8	— 5.6	— 1.4	— 2.7	—2.8	— 1.0	— .2
1902–03	— 5.7	— 3.7	— 3.1	— 6.1	— 8.2	— 9.8	—11.1	—10.1	—6.5	— 7.5	—9.0
1903–04	— 9.3	—10.5	— 9.8	— 6.0	— 6.3	—11.0	—13.6	—11.4	—6.3	— 2.4	—1.6
1904–05	— 0.8	—10.4	— 9.5	— 6.0	— 6.5	— 6.7	— 8.5	— 8.8	—9.5	—15.6	+5.2
1905–06	— 5.0	— 6.6	— 8.0	— 7.4	— 7.6	— 7.2	— 6.6	— 5.2	—1.8	— .1	—2.6
1906–07	—12.2	—10.4	—11.8	— 9.6	— 9.4	— 8.4	— 5.8	— 6.4	—5.3	— 4.8	—3.5
1907–08	—15.5	—13.5	—12.8	— 8.2	— 6.1	— 6.4	— 2.9	— .2	+2.0	+ 4.0	—2.8
1908–09	+ .8	— 4.6	— 3.9	— 4.0	— 4.6	— 4.3	— 1.0	— 3.0	—1.4	+ 5.7	+8.5
1909–10	+ 4.6	+ 1.8	+ 1.7	+ 1.2	— .6	— .7	— .8	— 1.0	—3.3	— 1.9	—3.7
1910–11	— 5.3	— 9.2	— 6.6	— 6.2	— 5.1	— 3.2	— 5.0	— 3.1	—1.6	— .7	—5.9
1911–12	— 9.7	— 7.9	— 7.8	— .8	— .6	+ 1.6	+ 4.4	+ 1.0	+2.0	+ .5	—4.0
1912–13	—11.5	— 8.0	— 7.5	— 8.8	— 9.4	— 6.6	— 6.1	— 7.2	—4.2	— 3.6	—3.5
1913–14	—14.6	—12.2	— 8.1	— 5.8	— 7.6	— 7.3	— 7.5	— 8.0	—5.3	— 4.6	—6.4
1921–22	—12.4	—11.6	—10.2	— 5.0	— 1.0	— 5.4	+ .2	— 4.8	—1.4	— 2.9	—5.0
1922–23	— 5.4	— 5.6	— 4.0	+ 2.3	+ 1.6	— 4.8	— 4.6	— 4.9	—4.0	— 4.0	—2.7
1923–24	—11.6	— 8.4	— .9	+ .2	+ .2	+ .4	+ 4.4	0	+2.5	+ 1.6	+1.1
1924–25	— 8.8	—18.2	—17.9	—13.9	—15.3	— 6.8	— 6.9	— 8.4	—3.8	+ 1.0	—4.1
1925–26	— 1.4	+ 1.4	+ 4.6	+16.2	+12.1	+ 5.2	+ 3.6	+ 2.1	+1.4	— 3.2	—5.4
1926–27	—12.9	—14.9	— 9.2	— 6.5	— 4.8	— 1.8	— 2.6	— 5.9	—4.8	— 2.8	—1.7
1927–28	—13.3	—14.5	— 6.3	— 5.4	— 2.1	+ .7	+ 2.1	+ 1.6	— .9	+ .6	+5.6

* Data obtained by subtracting the average price of the Chicago May future, as shown in Table II, from the weighted average price of the cash wheat, as given in *Wheat and Rye Statistics*, Table 70, and *Crops and Markets*, and reproduced in appendix tables of WHEAT STUDIES, June 1929, V, No. 7.

TABLE IV.—CASH–FUTURE SPREAD, NO. 2 RED WINTER WHEAT AT ST. LOUIS AND CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1899 TO MAY 1914 AND JULY 1921 TO MAY 1928*

(*Cents per bushel*)

Crop year, July–June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1899–00	— 5.8	— 4.8	— 4.6	— 3.1	— 1.8	+ 1.4	+ 3.3	+ 4.6	+ 5.7	+ 5.8	+ 5.5
1900–01	— 8.6	— 6.6	— 4.5	— 4.8	— 2.6	— 1.4	— 2.7	— 1.5	— 0.9	+ 2.3	+ 2.0
1901–02	— 7.0	— 5.7	— 3.4	— 1.5	— 1.8	+ 3.4	+ 8.6	+ 8.3	+ 7.2	+ 7.0	+ 6.8
1902–03	— 4.7	— 3.7	— 3.1	— 3.1	— 6.2	— 4.8	— 3.1	— 2.1	— 1.5	— 3.7	— 3.0
1903–04	+ .7	— 2.5	+ 2.2	+ 8.0	+ 8.7	+10.0	+ 4.4	+ 5.6	+ 9.7	+14.6	+14.4
1904–05	+ 9.2	— 3.4	+ 2.5	+ 6.0	+ 3.5	+ 3.3	+ 2.5	+ .2	+ 1.5	+ .4	+12.2
1905–06	0	— 1.6	0	+ 4.6	+ 3.4	+ 4.8	+ 6.4	+ 8.8	+13.2	+15.9	+11.4
1906–07	— 8.2	— 8.4	— 5.8	— 2.6	— 3.4	— 2.4	+ .2	— .4	+ .7	+ .2	— 4.5
1907–08	—13.5	—12.5	—10.8	— 5.2	— 6.1	— 3.4	+ .1	+ 3.8	+ 6.0	+ 6.0	— .8
1908–09	— 4.2	— 4.6	+ .1	0	+ .4	+ .7	+ 4.0	+11.0	+13.6	+11.7	+ 9.5
1909–10	+ 3.6	+11.8	+13.7	+18.2	+17.4	+17.3	+18.2	+15.0	+ 9.7	+ 2.1	+ 5.3
1910–11	— 2.3	— 7.2	— 3.6	— 1.2	— .1	+ 1.8	+ 3.0	+ 2.9	+ 3.4	+ 1.3	— 1.9
1911–12	—12.7	—12.9	— 8.8	— 4.8	— 4.6	— 1.4	+ 1.4	— 1.0	+ 1.0	+ 4.5	+ 6.0
1912–13	— 0.5	+ 7.0	+ 7.5	+12.2	+11.6	+16.4	+17.9	+15.8	+17.8	+17.4	+13.5
1913–14	—11.6	— 7.2	— 1.1	+ 3.2	+ 3.4	+ 3.7	+ 3.5	+ 1.0	+ 1.7	+ 2.4	— .4
1921–22	— 7.4	— 3.6	+ 3.8	+11.0	+10.0	+ 6.6	+ 9.2	+ 4.2	+ 6.6	+ 3.2	— 1.0
1922–23	— 6.4	— .6	+ 6.0	+12.3	+13.6	+14.2	+18.4	+19.1	+16.0	+15.0	+14.3
1923–24	—10.6	—10.4	— .9	+ 4.2	+ 3.2	+ 5.4	+ 7.4	+ 7.0	+ 7.5	+10.6	+ 7.1
1924–25	+ 6.2	+ .8	+ 2.1	+ 5.1	+ 4.7	+10.2	+21.1	+12.6	+11.2	+27.0	+18.9
1925–26	+ 3.6	+ 9.4	+17.6	+28.2	+20.1	+17.2	+19.6	+16.1	+10.4	+ 8.8	+ 1.6
1926–27	— 7.9	—11.9	— 5.2	— 5.5	— 5.8	— 2.8	— 1.6	— 5.9	— 7.8	— 4.8	— 1.7
1927–28	— 8.3	— 7.5	+ 4.7	+11.6	+ 7.8	+12.7	+20.1	+24.6	+30.1	+44.6	+41.6

* Data obtained as for Table III, but with the weighted average price of No. 2 Red Winter wheat for February 1908 corrected to read 99 instead of 102.

TABLE V.—CASH–FUTURE SPREAD, NO. 1 NORTHERN SPRING WHEAT AT MINNEAPOLIS AND CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1899 TO MAY 1914 AND JULY 1921 TO MAY 1928*

(Cents per bushel)

Crop year, July–June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1899–00	— 6.8	— 5.8	— 5.6	— 6.1	— 6.8	— 4.6	— 2.7	— 2.4	— 1.3	— .4	+ .5
1900–01	— 5.6	— 5.6	— 4.5	— 2.8	— 1.6	— .4	— 1.7	— 1.5	— 1.9	+ .3	0
1901–02	— 8.0	— 7.7	— 6.4	— 6.5	— 5.8	— 6.6	— 4.4	— 3.7	— 2.8	0	+ .8
1902–03	+ 2.3	+ 2.3	— 3.1	— 3.1	— 3.2	— 3.8	— 2.1	— 1.1	+ 1.5	+ .3	0
1903–04	+ 6.7	+ 9.5	+ 2.2	+ 3.0	+ 1.7	0	— .6	— 1.4	+ 1.7	+ 1.6	+ .4
1904–05	+ 9.2	+ 9.6	+ 4.5	+ 3.0	— 4.5	— 2.7	— 1.5	— 4.8	— 2.5	— 6.6	+17.2
1905–06	+19.0	+11.4	— 5.0	— 1.4	— 4.6	— 3.2	— 4.6	— 2.2	— .8	— .1	+ .4
1906–07	— 4.2	— 3.4	— 3.8	— 2.6	+ 1.6	+ 1.6	+ 3.2	+ 3.6	+ 3.7	+ 6.2	+ 2.5
1907–08	— .5	+ .5	+ 2.2	+ 3.8	+ 1.1	+ 3.6	+ 7.1	+10.8	+11.0	+10.0	+ 6.2
1908–09	+17.8	+12.4	+ 1.1	+ 1.0	— .6	+ 2.7	+ 2.0	0	— 1.4	— .3	+ 1.5
1909–10	+19.6	+ 5.8	+ 3.7	— .8	+ .4	+ 1.3	+ 2.2	+ 2.0	+ 1.7	+ 1.1	— .7
1910–11	+11.7	+ 3.8	+ 3.4	+ 6.8	+ 7.9	+ 6.8	+ 6.0	+ 8.9	+ 8.4	+ 7.3	+ 3.1
1911–12	+ 2.3	+ 4.1	+ 6.2	+ 5.2	+ 4.4	+ 3.6	+ 5.4	+ 4.0	+ 5.0	+ 1.5	+ 1.0
1912–13	+ 5.5	+ 1.0	— 6.5	— 6.8	— 8.4	— 8.6	— 4.1	— 6.2	— 5.2	— 3.6	+ .5
1913–14	— 5.6	— 7.2	— 8.1	— 5.8	— 5.6	— 5.3	— 5.5	— 1.0	— 1.3	— .6	— 2.4
1921–22	+36.6	+21.4	+18.8	+19.0	+15.0	+16.6	+21.2	+17.2	+15.6	+20.1	+22.0
1922–23	+30.6	+ 1.4	+ 2.0	+ 4.3	+ 7.6	+ 3.2	+ 4.4	+ 6.1	+ 4.0	+ 6.0	+ 9.3
1923–24	+ 4.4	+ 8.6	+11.1	+ 8.2	+ 5.2	+ 7.4	+10.4	+10.0	+14.5	+18.6	+17.1
1924–25	+ 8.2	— 6.2	— 7.9	— 4.9	—10.3	— 2.8	+ .1	— 2.4	— 3.8	0	— .1
1925–26	+ 3.6	+ 1.4	— 3.4	+ 7.2	+ 4.1	+ 2.2	— 1.4	— 1.9	+ 1.4	+ 1.8	+ 1.6
1926–27	+22.1	+ 3.1	+ 1.8	+ 3.5	+ 4.2	+ 6.2	+ 3.4	+ 1.1	+ 1.2	+ 4.2	+ 3.3
1927–28	— 2.3	— 6.5	— 3.3	— 4.4	— 3.2	+ .7	+ 4.1	+ 2.6	+ .1	+ 1.6	+ 2.6

* Data obtained as for Table III, but with the average price of No. 1 Northern Spring wheat for October 1901 corrected to read 67 instead of 62. The prices of No. 1 Northern Spring wheat for the crop years 1899–1900 to 1908–09 inclusive are simple averages, not weighted averages (see footnote above, p. 2).

TABLE VI.—DEFLATED CASH–FUTURE SPREAD, NO. 2 HARD WINTER WHEAT AT KANSAS CITY AND CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1899 TO MAY 1914 AND JULY 1921 TO MAY 1928, AND JULY–SEPTEMBER AND MARCH–MAY AVERAGES*

(Cents per bushel at 1913 price level)

Crop year July–June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	July–Sept. averages	Mar.–May averages
1899–00	—13.5	—13.5	—12.0	—12.7	—11.0	— 7.0	— 5.9	— 4.3	— 2.9	— 3.0	— 4.4	—13.0	—3.4
1900–01	—18.5	—17.2	—17.1	—13.7	—10.9	— 9.4	—11.0	— 9.5	— 8.7	— 2.2	— 3.8	—17.6	—4.9
1901–02	—12.3	—11.9	—10.3	— 9.2	— 8.4	— 6.9	— 1.7	— 3.3	— 3.4	— 1.2	— .2	—11.5	—1.6
1902–03	— 6.6	— 4.3	— 3.6	— 7.0	— 9.5	—11.3	—12.8	—11.7	— 7.5	— 8.7	—10.4	— 4.8	—8.9
1903–04	—11.0	—12.4	—11.6	— 7.1	— 7.4	—13.0	—16.0	—13.4	— 7.4	— 2.8	— 1.9	—11.7	—4.0
1904–05	— .9	—12.1	—11.0	— 7.0	— 7.5	— 7.8	— 9.9	—10.2	—11.0	—18.1	+ 6.0	— 8.0	—7.7
1905–06	— 5.8	— 7.6	— 9.2	— 8.5	— 8.8	— 8.3	— 7.6	— 6.0	— 2.1	— .1	— 3.0	— 7.5	—1.7
1906–07	—13.4	—11.4	—12.9	—10.5	—10.3	— 9.2	— 6.4	— 7.0	— 5.8	— 5.3	— 3.8	—12.6	—5.0
1907–08	—16.9	—14.8	—14.0	— 9.0	— 6.7	— 7.0	— 3.2	— .2	+ 2.2	+ 4.4	— 3.1	—15.2	+1.2
1908–09	+ .9	— 4.9	— 4.2	— 4.3	— 4.9	— 4.6	— 1.1	— 3.2	— 1.5	+ 6.1	+ 9.1	— 2.7	+4.6
1909–10	+ 4.5	+ 1.8	+ 1.7	+ 1.2	— .6	— .7	— .8	— 1.0	— 3.3	— 1.9	— 3.6	+ 2.7	—2.9
1910–11	— 5.6	— 9.7	— 6.9	— 6.5	— 5.4	— 3.4	— 5.2	— 3.3	— 1.7	— .7	— 6.2	— 7.4	—2.9
1911–12	—10.1	— 8.2	— 8.1	— .8	— .6	+ 1.7	+ 4.6	+ 1.0	+ 2.1	+ .5	— 4.2	— 8.8	— .5
1912–13	—11.5	— 8.0	— 8.0	— 8.8	— 9.4	— 6.6	— 6.1	— 7.2	— 4.2	— 3.6	— 3.5	— 9.2	—3.8
1913–14	—14.7	—12.3	— 8.2	— 5.9	— 7.7	— 7.4	— 7.6	— 8.1	— 5.4	— 4.6	— 6.5	—11.7	—5.5
1921–22	— 8.7	— 8.2	— 7.2	— 4.0	— .7	— 3.8	+ .1	— 3.4	— 1.0	— 2.0	— 3.5	— 8.0	—2.2
1922–23	— 3.5	— 3.6	— 2.6	+ 1.5	+ 1.0	— 3.1	— 3.0	— 3.1	— 2.6	— 2.6	— 1.7	— 3.2	—2.3
1923–24	— 7.7	— 5.6	— .6	+ .1	+ .1	+ .3	+ 2.9	0	+ 1.7	+ 1.1	+ .7	— 4.6	+1.2
1924–25	— 5.7	—11.8	—11.6	— 9.0	— 9.9	— 4.4	— 4.5	— 5.4	— 2.5	+ .6	— 2.6	— 9.7	—1.5
1925–26	— .9	+ .9	+ 3.0	+10.4	+ 7.8	+ 3.3	+ 2.3	+ 1.3	+ .9	— 2.1	— 3.5	+ 1.0	—1.6
1926–27	— 8.8	—10.1	— 6.2	— 4.4	— 3.3	— 1.2	— 1.8	— 4.0	— 3.3	— 1.9	— 1.2	— 8.4	—2.1
1927–28	— 9.0	— 9.8	— 4.3	— 3.7	— 1.4	+ .5	+ 1.4	+ 1.1	— .6	+ .4	+ 3.8	— 7.7	+1.2

* Data of Table III deflated by dividing the monthly averages for each crop year by the average wholesale price index number for the crop year, as shown in Table X.

TABLE VII.—DEFLATED CASH–FUTURE SPREAD, NO. 2 RED WINTER WHEAT AT ST. LOUIS AND CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1899 TO MAY 1914 AND JULY 1921 TO MAY 1928, AND JULY–SEPTEMBER AND MARCH–MAY AVERAGES*

(Cents per bushel at 1913 price level)

Crop year July–June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	July–Sept. averages	Mar.–May averages
1899-00	— 7.3	— 6.0	— 5.8	— 3.9	— 2.3	+ 1.8	+ 4.1	+ 5.8	+ 7.1	+ 7.3	+ 6.9	— 6.4	+ 7.1
1900-01	—10.9	— 8.4	— 5.7	— 6.1	— 3.3	— 1.8	— 3.4	— 1.9	— 1.1	+ 2.9	+ 2.5	— 8.3	+ 1.4
1901-02	— 8.6	— 7.0	— 4.2	— 1.8	— 2.2	+ 4.2	+10.6	+10.2	+ 8.8	+ 8.6	+ 8.4	— 6.6	+ 8.6
1902-03	— 5.4	— 4.3	— 3.6	— 3.6	— 7.2	— 5.5	— 3.6	— 2.4	— 1.7	— 4.3	— 3.5	— 4.4	— 3.2
1903-04	+ .8	— 2.9	+ 2.6	+ 9.4	+10.3	+11.8	+ 5.2	+ 6.6	+11.4	+17.2	+17.0	+ .2	+15.2
1904-05	+10.7	— 3.9	+ 2.9	+ 7.0	+ 4.1	+ 3.8	+ 2.9	+ .2	+ 1.7	+ .5	+14.2	+ 3.2	+ 5.5
1905-06	0	— 1.8	0	+ 5.3	+ 3.9	+ 5.5	+ 7.4	+10.1	+15.2	+18.3	+13.1	— .6	+15.5
1906-07	— 9.0	— 9.2	— 6.4	— 2.8	— 3.7	— 2.6	+ .2	— .4	+ .8	+ .2	— 4.9	— 8.2	— 1.3
1907-08	—14.8	—13.7	—11.8	— 5.7	— 6.7	— 3.7	+ .1	+ 4.0	+ 6.6	+ 6.6	— .9	—13.4	+ 4.1
1908-09	— 4.5	— 4.9	+ .1	0	+ .4	+ .8	+ 4.3	+11.8	+14.6	+12.6	+10.2	— 3.1	+12.5
1909-10	+ 3.5	+11.6	+13.5	+17.9	+17.1	+17.0	+17.9	+14.8	+ 9.6	+ 2.1	+ 5.2	+ 9.5	+ 5.6
1910-11	— 2.4	— 7.6	— 3.8	— 1.3	— .1	+ 1.9	+ 3.2	+ 3.0	+ 3.6	+ 1.4	— 2.0	— 4.6	+ 1.0
1911-12	—13.3	—13.5	— 9.2	— 5.0	— 4.8	— 1.5	+ 1.5	— 1.0	+ 1.0	+ 4.7	+ 6.3	—12.0	+ 4.0
1912-13	— .5	+ 7.0	+ 7.5	+12.2	+11.6	+16.4	+17.9	+15.8	+17.8	+17.4	+13.5	+ 4.7	+16.2
1913-14	—11.7	— 7.3	— 1.1	+ 3.2	+ 3.4	+ 3.7	+ 3.5	+ 1.0	+ 1.7	+ 2.4	— .4	— 6.7	+ 1.2
1921-22	— 5.2	— 2.5	+ 2.6	+ 7.7	+ 7.0	+ 4.6	+ 6.5	+ 3.0	+ 4.6	+ 2.2	— .7	— 1.7	+ 2.0
1922-23	— 4.1	— .4	+ 3.9	+ 7.9	+ 8.7	+ 9.1	+11.8	+12.3	+ 8.7	+ 9.6	+ 9.2	— .2	+ 9.2
1923-24	— 7.0	— 6.9	— .6	+ 2.8	+ 2.1	+ 3.6	+ 4.9	+ 4.7	+ 5.0	+ 7.0	+ 4.7	— 4.8	+ 5.6
1924-25	+ 4.0	+ .5	+ 1.4	+ 3.3	+ 3.0	+ 6.6	+13.6	+ 8.1	+ 7.2	+17.4	+12.2	+ 2.0	+12.3
1925-26	+ 2.3	+ 6.0	+11.3	+18.1	+12.9	+11.0	+12.6	+10.3	+ 6.7	+ 5.7	+ 1.0	+ 6.5	+ 4.5
1926-27	— 5.4	— 8.1	— 3.5	— 3.7	— 3.9	— 1.9	— 1.1	— 4.0	— 5.3	— 3.3	— 1.2	— 5.7	— 3.3
1927-28	— 5.6	— 5.1	+ 3.2	+ 7.9	+ 5.3	+ 8.6	+13.6	+16.7	+20.4	+30.3	+28.2	— 2.5	+26.3

* Data of Table IV deflated by dividing the monthly averages for each crop year by the average wholesale price index number for the crop year, as shown in Table X.

TABLE VIII.—DEFLATED CASH–FUTURE SPREAD, NO. 1 NORTHERN SPRING WHEAT AT MINNEAPOLIS AND CHICAGO MAY WHEAT FUTURE, MONTHLY, JULY 1899 TO MAY 1914 AND JULY 1921 TO MAY 1928, AND SEPTEMBER–NOVEMBER AND MARCH–MAY AVERAGES*

(Cents per bushel at 1913 price level)

Crop year July–June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Sept.–Nov. averages	Mar.–May averages
1899–00	— 8.5	— 7.3	— 7.0	— 7.6	— 8.5	— 5.8	— 3.4	— 3.0	— 1.6	— 0.5	+ 0.6	— 7.7	— 0.5
1900–01	— 7.1	— 7.1	— 5.7	— 3.5	— 2.0	— .5	— 2.2	— 1.9	— 2.4	+ .4	0	— 3.7	— .7
1901–02	— 9.8	— 9.5	— 7.9	— 8.0	— 7.1	— 8.1	— 5.4	— 4.5	— 3.4	0	+ 1.0	— 7.7	— .8
1902–03	+ 2.7	+ 2.7	— 3.6	— 3.6	— 3.7	— 4.4	— 2.4	— 1.3	+ 1.7	+ .3	0	— 3.6	+ .7
1903–04	+ 7.9	+11.2	+ 2.6	+ 3.5	+ 2.0	0	— .7	— 1.7	+ 2.0	+ 1.9	+ .5	+ 2.7	+ 1.5
1904–05	+10.7	+11.1	+ 5.2	+ 3.5	— 5.2	— 3.1	— 1.7	— 5.6	— 2.9	— 7.7	+20.0	+ 1.2	+ 3.1
1905–06	+21.9	+13.1	— 5.8	— 1.6	— 5.3	— 3.7	— 5.3	— 2.5	— .9	— .1	+ .5	— 4.2	— .2
1906–07	— 4.6	— 3.7	— 4.2	— 2.8	+ 1.8	+ 1.8	+ 3.5	+ 3.9	+ 4.1	+ 6.8	+ 2.7	— 1.7	+ 4.5
1907–08	— .5	+ .5	+ 2.4	+ 4.2	+ 1.2	+ 3.9	+ 7.8	+11.8	+12.0	+10.9	+ 6.8	+ 2.6	+ 9.9
1908–09	+19.1	+13.3	+ 1.2	+ 1.1	— .6	+ 2.9	+ 2.2	0	— 1.5	— .3	+ 1.6	+ .6	— .1
1909–10	+19.3	+ 5.7	+ 3.6	— .8	+ .4	+ 1.3	+ 2.2	+ 2.0	+ 1.7	+ 1.1	— .7	+ 1.1	+ .7
1910–11	+12.3	+ 4.0	+ 3.6	+ 7.1	+ 8.3	+ 7.1	+ 6.3	+ 9.3	+ 8.8	+ 7.7	+ 3.3	+ 6.3	+ 6.6
1911–12	+ 2.4	+ 4.3	+ 6.5	+ 5.4	+ 4.6	+ 3.8	+ 5.6	+ 4.2	+ 5.2	+ 1.6	+ 1.0	+ 5.5	+ 2.6
1912–13	+ 5.5	+ 1.0	— 6.5	— 6.8	— 8.4	— 8.6	— 4.1	— 6.2	— 5.2	— 3.6	+ .5	— 7.2	— 2.8
1913–14	— 5.7	— 7.3	— 8.2	— 5.9	— 5.7	— 5.4	— 5.6	— 1.0	— 1.3	— .6	— 2.4	— 6.6	— 1.4
1921–22	+25.7	+15.0	+13.2	+13.4	+10.5	+11.7	+14.9	+12.1	+11.0	+14.1	+15.5	+12.4	+13.5
1922–23	+19.6	+ .9	+ 1.3	+ 2.8	+ 4.9	+ 2.1	+ 2.8	+ 3.9	+ 2.6	+ 3.9	+ 6.0	+ 3.0	+ 4.2
1923–24	+ 2.9	+ 5.7	+ 7.1	+ 5.5	+ 3.5	+ 4.9	+ 6.9	+ 6.7	+ 9.6	+12.4	+11.4	+ 5.4	+11.1
1924–25	+ 5.3	— 4.0	— 5.1	— 3.2	— 6.7	— 1.8	+ .1	— 1.6	— 2.5	0	— .1	— 5.0	— .9
1925–26	+ 2.3	+ .9	— 2.2	+ 4.6	+ 2.6	+ 1.4	— .9	— 1.2	+ .9	+ 1.2	+ 1.0	+ 1.7	+ 1.0
1926–27	+15.0	+ 2.1	+ 1.2	+ 2.4	+ 2.9	+ 4.2	+ 2.3	+ .7	+ .8	+ 2.9	+ 2.2	+ 2.2	+ 2.0
1927–28	— 1.6	— 4.4	— 2.2	— 3.0	— 2.2	+ .7	+ 2.8	+ 1.8	+ .1	+ 1.1	+ 1.8	— 2.5	+ 1.0

* Data of Table V deflated by dividing the monthly averages for each crop year by the average wholesale price index number for the crop year, as shown in Table X.

TABLE IX.—DEFLATED CHANGES IN CASH–FUTURE SPREADS AND RELATED SERIES, 1899–1900 TO 1913–14 AND 1921–22 TO 1927–28

Crop year July–June	Deflated changes in cash-future spreads[a]			Total U.S. wheat stocks at beginning of year (July 1)[b]	Wheat production in principal states[c]			Deflated spread between Chicago Sept. and May futures in Aug.[d]
	No. 2 Hard Winter, July-Sept. to March-May	No. 2 Red Winter, July-Sept. to March-May	No. 1 Northern Spring, Sept.-Nov. to March-May		Hard winter-wheat states	Red winter-wheat states	Spring-wheat states	
1899–00	+ 9.6	+13.5	+7.2	195.8	73.5	109.9	159.5	+ 6.5
1900–01	+12.7	+ 9.7	+3.0	188.2	125.9	72.0	86.8	+ 6.5
1901–02	+ 9.9	+15.2	+6.9	134.2	164.1	155.3	193.4	+ 7.2
1902–03	— 4.1	+ 1.2	+4.3	130.4	113.1	185.3	189.0	— .3
1903–04	+ 7.7	+15.0	—1.2	109.7	156.9	117.1	175.9	+ 3.2
1904–05	+ .3	+ 2.3	+1.9	106.3	115.0	100.7	156.4	+ 1.7
1905–06	+ 5.8	+16.1	+4.0	78.1	139.5	153.4	195.0	+ 4.9
1906–07	+ 7.6	+ 6.9	+6.2	139.7	155.7	190.6	179.0	+ 6.8
1907–08	+16.4	+17.5	+7.3	192.4	120.2	164.1	159.2	+12.3
1908–09	+ 7.3	+15.6	— .7	95.5	139.2	160.4	178.6	+ 6.1
1909–10	— 5.6	— 3.9	— .4	59.8	139.3	153.3	223.7	+ .6
1910–11	+ 4.5	+ 5.6	+ .3	110.1	127.5	155.5	156.9	+ 8.4
1911–12	+ 8.3	+16.0	—2.9	126.0	101.9	166.1	144.2	+10.2
1912–13	+ 5.4	+11.5	+4.4	104.6	167.4	75.7	282.4	+ 3.5
1913–14	+ 6.2	+ 7.9	+5.2	130.5	166.8	178.2	201.5	+ 8.5
1921–22	+ 5.8	+ 3.7	+1.1	129.4	235.9	160.0	163.1	+ 4.0
1922–23	+ .9	+ 9.4	+1.2	126.4	214.0	183.3	246.6	+ 3.9
1923–24	+ 5.8	+10.4	+5.7	182.1	153.1	200.7	170.0	+ 6.2
1924–25	+ 8.2	+10.3	+4.1	147.1	275.4	140.5	258.3	+ 6.4
1925–26	— 2.6	— 2.0	— .7	125.5	138.7	131.9	209.5	+ 1.7
1926–27	+ 6.3	+ 2.4	— .2	102.1	263.9	160.6	158.2	+ 6.2
1927–28	+ 8.9	+28.8	+3.5	125.1	218.5	127.7	276.7	+ 6.4

[a] Cents per bushel at 1913 price level; differences between figures in last two columns of Tables VI, VII, and VIII, in the order shown. [b] Million bushels; data from WHEAT STUDIES, February 1928, IV, No. 4, Table II, column 7.

[c] Million bushels; based on U.S. Department of Agriculture estimates of production by states, taking as principal hard winter-wheat states, Kansas, Nebraska, Oklahoma, and Indian Territory; as principal red winter-wheat states, Pennsylvania, Ohio, Indiana, Illinois, and Missouri; and as principal spring-wheat states, Minnesota, North Dakota, South Dakota, and Montana.

[d] Cents per bushel at 1913 price level; based on daily spreads as compiled from *Annual Reports* of the Chicago Board of Trade and from the Chicago *Daily Trade Bulletin*, deflated by dividing by the average wholesale price index number for the crop year, as shown in Table X.

TABLE X.—FARM STOCKS OF WHEAT, MARCH 1, AND SEPTEMBER–MARCH CHANGE IN PRICE OF CHICAGO MAY FUTURE, 1899–1900 TO 1913–14 AND 1921–22 TO 1927–28

Crop year, July–June	Farm stocks, March 1[a] (*million bushels*)	Price change, Sept.–March[b] (*cents per bu.*)	Wholesale price index number[c] (*percentage of 1913 average*)	Deflated price change[d] (*cents per bu. at 1913 price level*)
1899–00	183.3	— 8.3	79.8	—10.4
1900–01	147.7	— 4.6	78.9	— 5.8
1901–02	181.7	+ .4	81.4	+ .5
1902–03	174.7	+ 4.4	86.6	+ 5.1
1903–04	136.8	+12.5	84.8	+14.7
1904–05	118.2	+ 1.0	86.1	+ 1.2
1905–06	163.9	— 8.2	86.8	— 9.4
1906–07	211.9	— 1.5	91.2	— 1.6
1907–08	148.4	— 9.8	91.5	—10.7
1908–09	137.6	+14.5	92.9	+15.6
1909–10	163.4	+13.0	101.5	+12.8
1910–11	162.7	—16.0	95.2	—16.8
1911–12	122.0	+ .2	95.8	+ .2
1912–13	156.5	— 5.3	100.1	— 5.3
1913–14	151.8	— 1.8	99.0	— 1.8
1921–22	134.3	+ 3.2	142.3	+ 2.2
1922–23	156.1	+12.0	155.7	+ 7.7
1923–24	137.7	— 3.4	150.3	— 2.3
1924–25	112.1	+36.9	154.8	+23.8
1925–26	100.1	+ 6.2	155.7	+ 4.0
1926–27	130.2	— 3.4	147.2	— 2.3
1927–28	130.9	+ 1.6	147.4	+ 1.1

[a] Data from *Crops and Markets* for March of the years 1927, 1928, and 1929. [b] Computed from data in Table II.
[c] Crop-year averages (July–June) of the U.S. Bureau of Labor Statistics "all commodities" index number computed from monthly data in *Index Numbers of Wholesale Prices on Pre-war Base, 1890 to 1927* (1928) and from data in recent numbers of the *Monthly Labor Review*.
[d] Column 3 divided by column 4.