

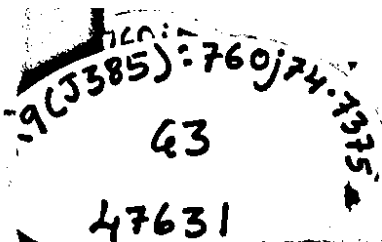
Annual Fluctuations in the Price of Corn

BY GEOFFREY SHEPHERD

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

R. M. HUGHES, Acting Director

AGRICULTURAL ECONOMICS SECTION



X9(J385):760j74.7375
G5
047631

SEARCH BULLETIN NO. 164
June 1933
AMES, IOWA

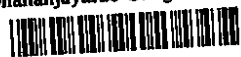
June, 1933

Bulletin No. 164

Annual Fluctuations in the Price of Corn

BY GEOFFREY SHEPHERD

Dhananjayrao Gadgil Library



GIPE-PUNE-047631

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

R. M. HUGHES, Acting Director

AGRICULTURAL ECONOMICS SECTION

AMES, IOWA

CONTENTS

	Page
Summary	283
Statistical technique	286
Changes in the value of money.....	286
Trends	286
Annual fluctuations in corn values at the farm.....	288
The United States Dec. 1 farm value of corn.....	288
Influence of fluctuations in corn production.....	289
Pre-war period, 1899 to 1915.....	291
Post-war period, 1922 to 1929.....	293
Influence of size of corn crop upon its total gross value.....	293
Other factors affecting the Dec. 1 farm value of corn.....	295
Pre-war period	295
Post-war period	297
Annual fluctuations in the Iowa Dec. 1 farm value of corn.....	301
For the state as a whole.....	301
For Iowa districts 4, 5 and 6.....	303
Annual fluctuations in corn values at Chicago.....	306
Influence of fluctuations in corn production.....	306
Pre-war period	306
Post-war period	308
Other factors affecting the Dec. value of corn at Chicago.....	308
Pre-war period	308
War period	311
Post-war period	311
General conclusions	315
Literature cited	316

SUMMARY

UNITED STATES DEC. 1 AVERAGE FARM VALUE OF CORN

The United States average farm value of corn per bushel Dec. 1 before the World War was determined almost entirely by the size of the United States corn crop. The closeness of the relation is indicated by the simple correlation coefficient $-.9738$. The regression of corn value on corn production was -1.62 . Since the war, this regression has decreased to -1.54 .

Since the war, the farm value of corn has become sensitive to other influences besides the size of the corn crop. Three other factors now seem to influence the value of corn—the numbers of livestock on farms, the rate of industrial production, and perhaps the west-east corn production ratio. The period since the war is so short, however, that these conclusions must be regarded as tentative.

IOWA DEC. 1 AVERAGE FARM VALUE OF CORN

The Iowa average farm value of corn Dec. 1 before the war, like the United States farm value, was determined almost entirely by the size of the United States corn crop; but the correlation coefficient was slightly lower ($-.9678$).

The regression of Iowa corn value on United States corn production was -2.34 . Iowa farm values thus fluctuated proportionally more than United States values did. Since the war, the regression has decreased slightly, from -2.34 to -1.99 .

CHICAGO DECEMBER VALUE OF NO. 3 YELLOW CORN

Before the World War, fluctuations in the December value of corn were largely explained by the action of three factors—the size of the corn crop, the quality of the crop and the number of livestock on farms.

Since the war, the Chicago December value of corn has become responsive to one or two additional factors; these are (a) industrial production and perhaps (b) the west-east corn production ratio.

The regression of Chicago corn value on United States corn production before the war was -1.64 . Since the war, it has increased to -2.22 . The post-war period is too short to say whether changes have taken place in the regression of the two other variables, corn quality and livestock numbers.

The drastic decline in the general price level in 1920 shifted the short-time trend of Chicago corn values downward. The decline in the price level that started in 1929 appears to be shifting the trend downward again. The new trend will probably be considerably higher than corn values at the present

time, but lower than the trend from 1922 to 1929, unless the general price level rises substantially.

Corn prices are determined by two groups of forces, (a) those which recur annually, like changes in the size of the corn crop, and (b) those which happen but once and may not occur again. Correlation studies such as the present one deal only with the first group of forces or factors. They may lead the investigator astray if they are taken as a complete explanation of corn price movements. They provide only a partial explanation. But by measuring the effect of the one group of factors, they clear the way for a more accurate evaluation of the effect of the other group.

Annual Fluctuations in the Price of Corn¹

BY GEOFFREY SHEPHERD²

The price of corn fluctuates more from year to year than the price of any other major grain crop grown in the United States (8).

In December, 1923, for example, No. 3 Yellow corn at Chicago was selling at 71 cents a bushel. A year later it had nearly doubled in price; corn stood then, in December, 1924, at \$1.20. During the following year corn came down again so that by December, 1925, the price had fallen to 76 cents.

Large fluctuations of this sort are not difficult to explain. The chief reason for the high price of corn in 1924 was the small size of the 1924 corn crop. But the movements of the price of corn in some other years cannot be so easily accounted for. In 1927, for instance, the corn crop was 2.5 percent larger than the crop the year before. Yet the price in December, 1927, was 11 cents *higher* than the price in December, 1926; and the difference between the two prices increased as the season progressed. Or take the situation in 1925; the corn crop was average in size, but the price of corn in December was 8 cents below average.

Evidently other factors besides the size of the corn crop affect the price of corn. But what are the other factors? Are they physical things such as the numbers of livestock in the country or the size of the oats crop, or economic factors such as the price of hogs, or simply psychological speculative influences originating in the central grain markets? The question is important, because fluctuations in the price of corn have a disturbing effect upon the entire production program of Corn Belt farmers. Their livestock feeding plans are continually being upset by the instability of corn prices.

But can greater stability of corn prices be attained? Before this question can be answered, the factors that cause movements in the price of corn must be determined.

A previous publication (10) has reported the results of an investigation of long-time or secular movements in corn prices. The present bulletin deals with annual fluctuations. It is divided into two parts; the first part deals with fluctuations in the average price of corn at the farm, and the second, with fluctuations at a single dominant market, Chicago.

¹Project No. 10 of the Iowa Agricultural Experiment Station.

²The author greatly appreciates the suggestions and criticisms made by Dr. A. G. Black, chief, Agricultural Economics Section, and Prof. G. W. Snedecor, of the Mathematics Department, Iowa State College.

STATISTICAL TECHNIQUE

The statistical method used in this bulletin is a combination of graphic and numerical correlation technique.

The analysis begins with a preliminary study of the basic United States farm price and production data, which are available in series running back to 1866 (14).

As the analysis proceeds, especially when it begins to deal with Chicago corn prices, reasons for shortening the period to the years from 1899 to 1932 become apparent. (a) The prices for corn at Chicago before 1899 are not strictly comparable with those after 1899. (b) The data concerning live-stock numbers before 1900 appear to be inaccurate, since they decline for 9 years from 1890 to 1899, and then from 1899 to 1900 rise suddenly, more than they had fallen in the previous 9 years. (c) Some of the series, for instance the data for corn quality, run back no further than 1897. Because of these shortcomings of the data before 1899, the analysis in this bulletin, in the main, is restricted to the years from 1899 onward.

CHANGES IN THE VALUE OF MONEY

During the period from 1899 to 1932, great changes took place in the value of money. In an attempt to simplify the problem and remove the effects of these monetary changes, the original corn prices are divided each year by the corresponding index of the general price level (i.e., by the reciprocal of the value of money). The Bureau of Labor Statistics index of the general level of wholesale prices is used for this purpose.

Dividing the original corn prices by this index results in a series which may be called "deflated prices," "real prices," "adjusted prices," "purchasing power" (inaccurately), or "values" (11). The latter term has been chosen here, being less clumsy than the others.

This operation only partly removes the effect of changes in the value of money upon the price of corn, for this effect is not constant. It is shown later in this bulletin that in periods of declining price levels, the effect is different from that in times of rising prices; apparently the relationship is not simply one-to-one in any case. Until the way in which this relationship varies is more definitely ascertained, however (and this would be a study in itself), the generally used practice of dividing the price series throughout by the index of the general price level is probably the best.

TRENDS

A further question arises, concerning the trends evident in the data used. Nearly all the series show marked upward trends from 1899 to 1932. These trends could be handled either by leaving them in the original data and using time as a

separate variable, or by expressing the data as ratios to their trends (usually as some percentage of the trend value), or by expressing the data as first differences (i.e., as so much more or less each year than the year before).

The use of time as a separate variable—referred to in numerical correlation work as the method of simultaneous elimination of trends—cannot advantageously be used here.

“The assumption that the effect of factors which vary in time may be expressed as functions of numerically designated time is true only to the extent that such factors actually do vary in magnitude proportional to the associated numerical description assigned to time. This is seldom the case.” (12) That is, far from taking into account the changes that occur with the passage of time in the trends of the different factors involved, the method of simultaneous elimination of trends simply assumes that the trend of each factor rises or falls by a constant increment throughout. This condition is not realized in the present study; most of the trends either rise less rapidly in the latter part of the period than in the first, or cease altogether to rise. Furthermore, when the relationships between annual fluctuations in the different variables are obscured by trends, the graphic method of correlation analysis is rendered less trustworthy.

For these reasons, attention was turned to the other methods of dealing with trends—the trend ratio method and the first difference method mentioned above. In the early stages of the analysis, both of these methods were used. The results from the two methods were so similar that the study was completed on the basis of only the one method, that of trend ratios. A slight modification of the method was made in that the data were expressed as deviations above or below the trend line, in terms of percentage of the trend value. That is, if in 1905 the price of corn was 60 cents, and the trend value of corn prices that year was 50 cents, the corn price for that year would be represented as +20 percent.

The first task involved in the use of the trend ratio method is the selection of the type of trend line for each series and the method of fitting the trend lines to the data.

In the case of the corn value series, a straight line was fitted (by the method of least squares) to the original data from 1866 to 1919, inclusive. The data after 1920 require a separate trend line; the period is so short that the trend is represented simply by a horizontal line. In the case of the corn production series, a cubic parabola was mathematically fitted to the data from 1866 to 1928, the most recent year available when this study was begun. As time passed and more recent years have been added, extrapolations of this trend have begun to lose their validity. Accordingly, for the purposes of the present

study, the original parabolic trend is used for the years 1866 to 1916, but from 1917 to 1931 (the trend of acreage and of yield per acre during that period being horizontal), the average of the production for the period 1917 to 1931 is used as a horizontal trend line.

Straight lines are mathematically fitted to the other series used, except where noted. For the post-war period, the trends for all the other series are horizontal, running at a figure equal to the average from 1922 to 1929, inclusive. The only exception to this is the trend for livestock numbers, which declined steeply from 1918 onward. In this case a straight line is fitted by the method of least squares to the data from 1919 to 1931. These trends are extrapolated through 1932.

ANNUAL FLUCTUATIONS IN CORN VALUES AT THE FARM

THE UNITED STATES DEC. 1 FARM VALUE OF CORN

This section deals with average farm values. It begins with a study of the average value of corn at the farm for the United States as a whole. Then comes a study of the average farm value of corn for a more limited area, the state of Iowa. The section concludes with an analysis of average values for the different districts within Iowa.

The average farm value of corn Dec. 1 for the United States as a whole, for the period 1866 to 1932, is shown graphically in fig. 1. The trend lines are those described above.

The irregularity and extent of the fluctuations in the farm value of corn are well brought out in the chart. The standard deviation of the series, when the fluctuations are expressed in terms of percentage of trend values, is 17.47.

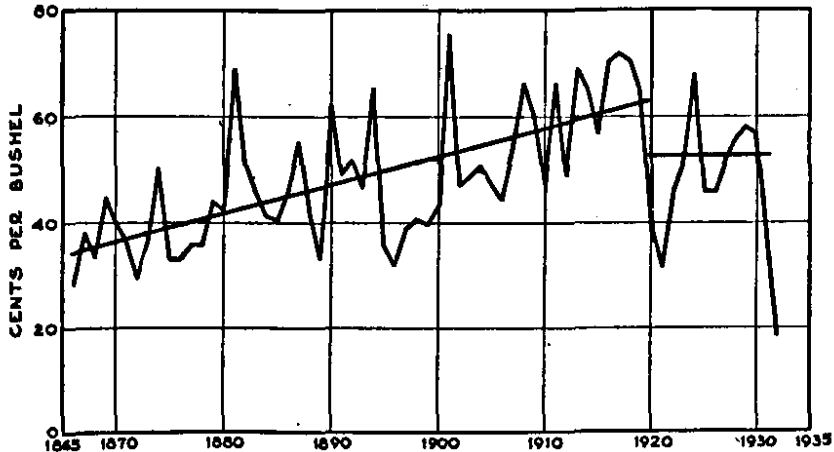


Fig. 1. Fluctuations in the United States Dec. 1 farm value of corn.

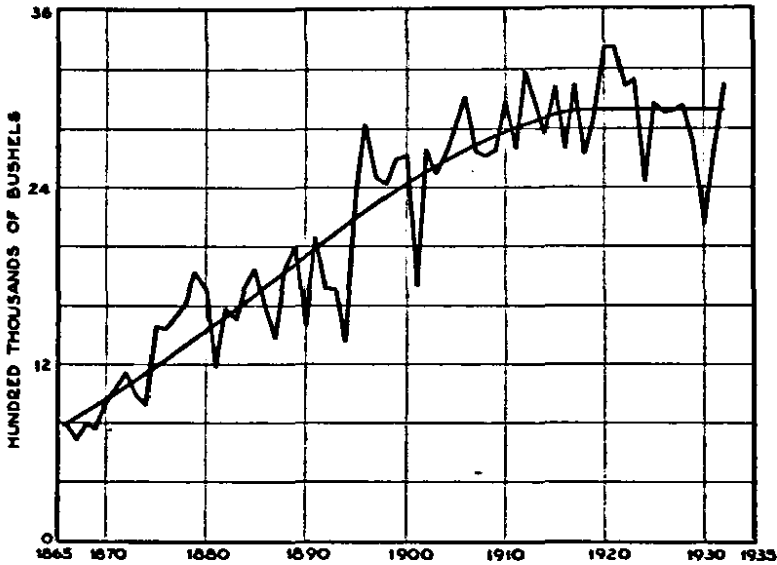


Fig. 2. United States corn production, 1866 to 1931.

INFLUENCE OF FLUCTUATIONS IN CORN PRODUCTION

The most obvious cause of these marked and irregular fluctuations in the value of corn is the variation from one year to another in the supply of corn.

From the point of view of the market, the supply of corn available each year consists of the production plus the stocks of old corn on farms and the visible supply in the channels of trade.³ This is the series used here to represent the supply of corn. For brevity, it will be referred to simply as corn production. This series is shown in fig. 2.

The relation between the percentage deviations from trend of the corn production series and of the United States Dec. 1 farm value series is shown in fig. 3. Figure 3A shows the percentage deviations from trend for these two series for the period 1866 to 1929, inclusive, plotted in the form of a scatter diagram, with corn value plotted on the vertical axis and corn production on the horizontal.

³Stocks of old corn on farms have a considerable effect upon values, but the influence of the visible supply is negligible. The correlation coefficient between production and value (1866-1915) when the visible supply is not included is exactly the same as when it is included. And adding visible supply as a third variable has almost no effect on the correlation coefficient; the coefficient when the visible supply is not included is only three points in the fourth decimal place lower than when it is included.

Henry Schultz, in an article dealing with changes in the demand for corn (9) subtracts the exports during the year and stocks on hand at the end of the year. In the present publication no subtractions of this sort are made, because we are dealing here with the influence of the supply of corn on the price, not with the influence of price on consumption.

There is a considerable amount of scatter about the line of relationship between the two series. In order to define the

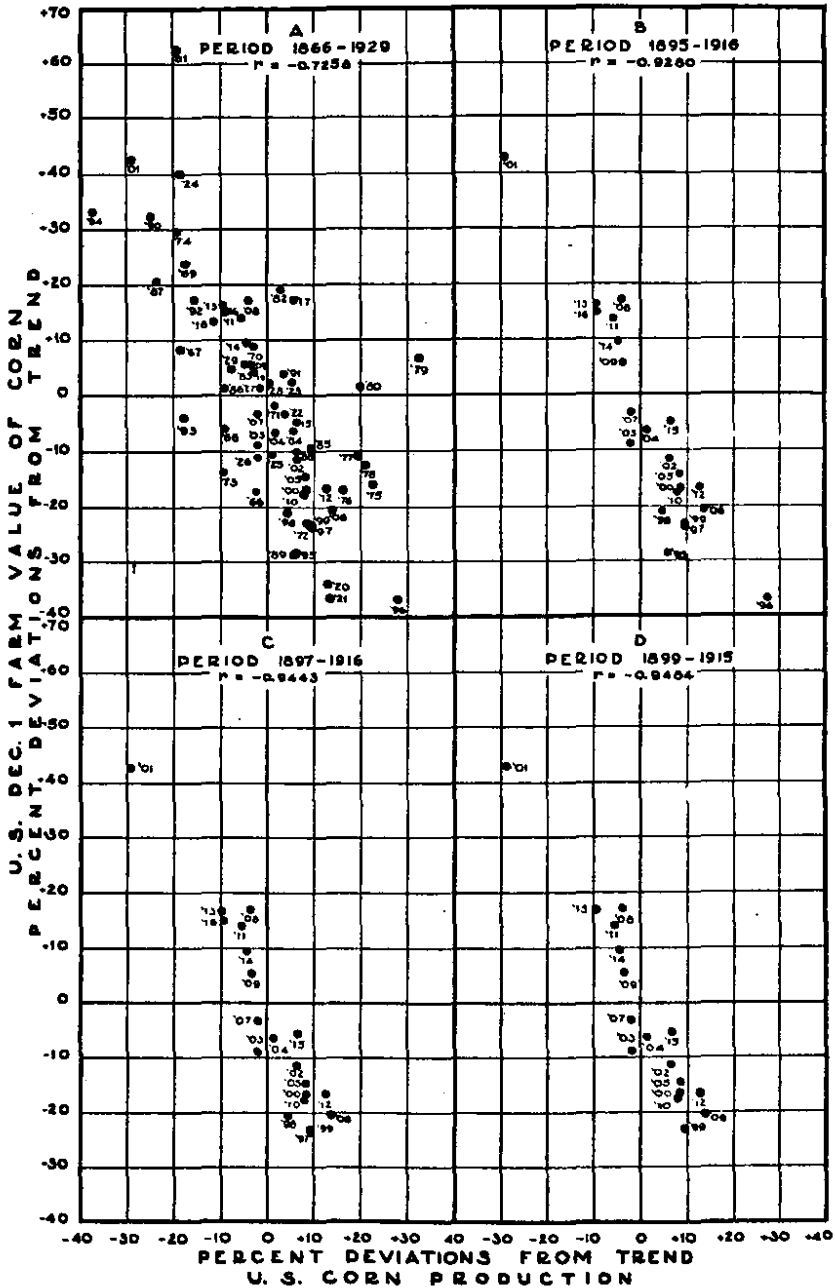


Fig. 3. Relationship between United States corn production and United States Dec. 1 farm value of corn.

picture more sharply, attention should be focused on a smaller section of the field, preferably a part that is least marred by wars and business upheavals and depressions. The clear-cut results of the study of a stable period then provide a base from which the extent of abnormal influences operating during disturbed periods can be measured.

Reasons for limiting the study to the years since 1899 were given earlier in this bulletin. Even the period since 1899, however, presents difficulties; it includes several years, from 1916 or 1917 to at least 1920, when normal relationships were distorted by the effects of the World War.

If these war years are omitted, the study can be based upon the two relatively stable periods before and after the war. The pre-war period runs from 1899 to 1915, inclusive; the post-war period runs from 1922 to 1929, when the present depression began.

The question then arises whether the pre-war period should be used as the basis for study, or the post-war period, or whether the two periods should be run together and handled as one.

There are objections to all three of these methods. The period before the war is going out of date; the relations between the different variables concerned may have changed considerably since then, especially under the influence of such a major upheaval as the war itself. On the other hand, the period since the war is very short for multiple correlation analysis. Relations appearing in so brief a period may be largely the result of chance. But if the third alternative is chosen and both periods are run together, any changes that have taken place in relations would be lost in the general averages.

The method finally chosen consists of keeping the pre-war and post-war periods separate, studying both separately, and then checking the results from the pre-war period against those from the post-war period. If any change in the pre-war relations has occurred since the war, the change can thereby be determined.

The procedure followed in this study, then, is (a) to determine the relations between the value of corn and the factors affecting it during the pre-war period, (b) to measure the extent to which abnormal influences affected the value of corn during and just after the World War, and (c) to determine whether the pre-war relations hold during the post-war period, and if they do not, to measure the changes that have taken place.

PRE-WAR PERIOD, 1899 TO 1915

Let us turn first to a study of the pre-war period. A series of scatter diagrams, based on successively shorter and shorter series within the original period from 1866 to 1929, show that

as more and more years are clipped off both ends of the series, the relations between the percentage deviations from trend of corn production and of corn value becomes more and more clearly defined. The diagrams are shown in figs. 3B, C and D.

The progressive increase in the correlation coefficients obtained with the use of the shorter and shorter series is shown in table I. The same trend lines are used throughout.

TABLE I. COEFFICIENTS OF CORRELATION BETWEEN U. S. AVERAGE FARM VALUE OF CORN AND U. S. CORN PRODUCTION.

Period	Coefficient
1866-1929	-.7256
1885-1916	-.8290
1897-1916	-.9443
1899-1915	-.9464

As a final step, the years from 1899 to 1915 are adopted as the basic pre-war period, and a new straight line trend is fitted to the corn value data for that period by the method of least squares.⁴ The simple correlation coefficient between the percentage deviations of corn values from this new corn value trend line, and the percentage deviations of corn production from the original long corn production trend line (which fits the 1899-1915 data well), is $-.9738$.

This relationship is shown graphically in fig. 4A. The chart shows a close grouping of the dots about the regression line

drawn in with slope determined from the formula $b = r \frac{\sigma_X}{\sigma_Y}$

This type of line, which Mordecai Ezekiel calls simply a price-quantity curve, is not the same thing as the demand curve of economic theory (3). A demand curve shows the amounts that consumers will take at different prices. A price-quantity curve shows the amounts that all classes—consumers, speculators and producers—will take or withhold. It shows the sum of the “demands” of all of these groups. Wicksteed calls this price-quantity curve the collective demand curve (17).

It is evident from fig. 4 that most of the annual fluctuation in the farm value of corn before the war was the result of fluctuations in corn production. The regression of corn value on corn production was -1.62 ; that is, for example, a corn crop 10 percent larger than average in size (i.e., 10 percent larger than the trend value), caused on the average a 16.2 percent decrease in the value of corn per bushel.

POST-WAR PERIOD, 1922 TO 1929

The correlation coefficient for the post-war period, $-.8378$, is considerably lower than for the period before the war. The

⁴Bureau of Labor Statistics indexes of the general price level by years are available in a series running back to 1891, but indexes by months run back only as far as 1890. Since the corn price series used in the preceding section runs back to 1866, it is converted to values by division by the annual general price level indexes.

The rest of this bulletin deals with data subsequent to 1890. From this point on, therefore, it is possible to divide the December corn prices by the December indexes. This procedure gives more accurate results than using the index for the year, and is adopted throughout the remainder of the bulletin.

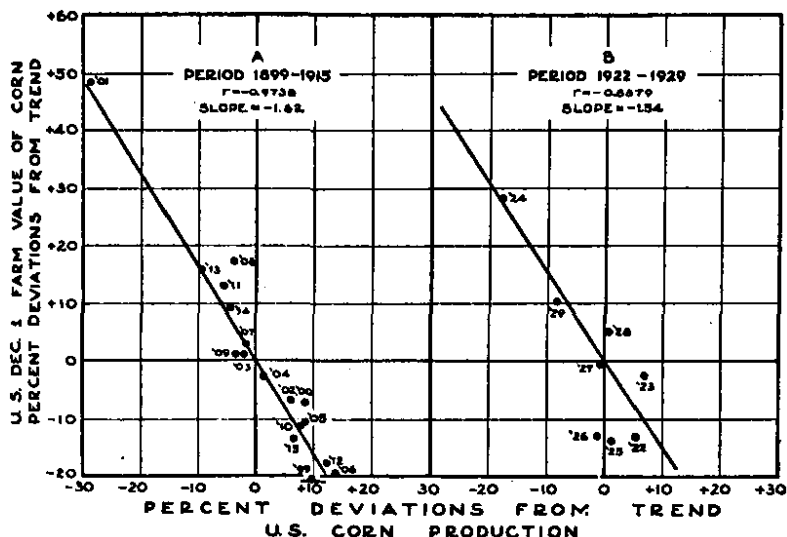


Fig. 4. Relation between United States corn production and United States Dec. 1 farm value of corn, 1899-1915 and 1922-1929.

years 1925 and 1926 are chiefly responsible for this, since they are more than 10 percent below the line of average relationship.

The post-war regression, -1.54 , is slightly lower than the pre-war regression, -1.62 . The number of post-war observations is so small, however, that the decrease in slope since the war is not significant.

INFLUENCE OF SIZE OF CORN CROP UPON ITS TOTAL GROSS VALUE

We may digress for a moment to consider the question whether a large crop of corn is worth as much as a small crop.

This question can be answered by first plotting the regression curve that would result if a high price per bushel exactly compensated for a small corn crop, and vice versa. Such a curve would be a "constant total value" curve. It would pass, for example, through the following coordinates: Production, 80 percent of average, and price, 125 percent of average; production, 100 percent of average, and price, 100 percent of average; production, 125 percent, and price, 80 percent; and so on for all other points whose coordinates multiplied together equal 10,000.

The line showing the regression of corn value on corn production may then be drawn in on the chart, and compared with the "constant total returns" curve. The two curves are shown in fig. 5.

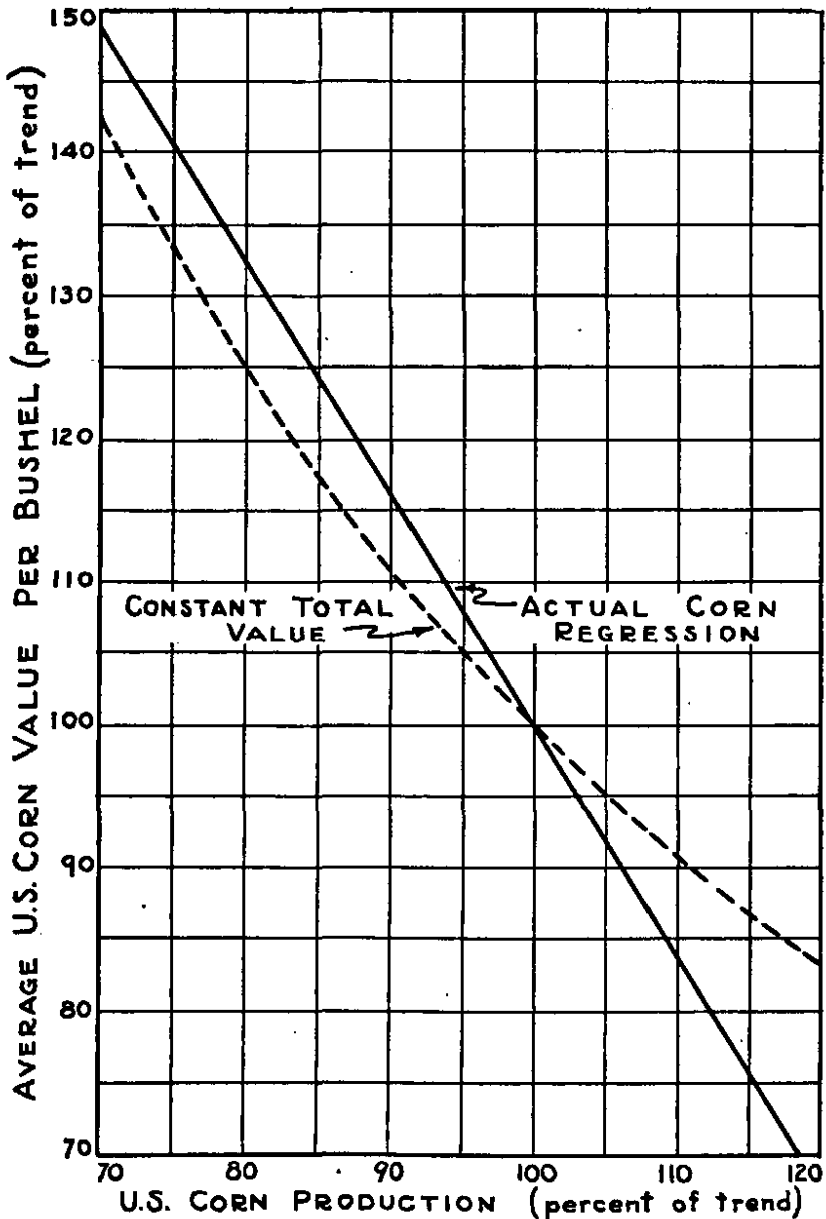


Fig. 5. Regression of corn value on corn production compared with a "constant total value" curve.

Wherever the regression line falls above and to the right of the constant value curve it represents total gross value greater than average, and conversely. The figure shows that as the

size of the corn crop decreases, the total gross value of the crop increases somewhat. As the size of the corn crop decreases below 80 percent of average, the total value of the crop ceases to increase and, in fact, gradually declines. The figure shows further that the larger the crop is above average, the lower is its total gross value. The point of maximum value appears to be at a crop size from 80 to 85 percent of average. Crops below that size, as well as crops above it, bring in a smaller total gross value.

There is wide popular interest in this question, but it really has very little significance. Iowa, the heaviest corn producing state in the Union, sells on the average only from 15 to 20 percent of its corn as cash grain. The figure for the United States as a whole is considerably smaller than this. When so small a percentage of the total crop is sold as cash grain, it is bootless to prove one thing or the other about the total value that would be received if all the crop were sold for cash. The results under the actual situation, in which the major proportion of the corn crop is fed to livestock, are probably very different from those obtained on the basis of all the crop being sold for cash. Since most of the corn crop is fed to livestock, the total value of the crop depends upon the value of the sales of livestock rather than of grain. And the one is not a simple function of the other.

OTHER FACTORS AFFECTING THE DEC. 1 FARM VALUE OF CORN

PRE-WAR PERIOD

The preceding sections have shown that fluctuations in the value of corn at the farm result largely from changes in the size of the corn crop.

After the influence of changes in crop size has been taken into account, however, a small amount of residual fluctuation in corn values still have to be explained. This residual fluctuation must be the result of changes in factors other than the size of the corn crop.

The number of livestock on farms may affect the value of corn at the farm; perhaps the prices of other feed crops such as oats and barley should also be considered. More than a dozen possible factors should be taken into account.

Accordingly, a number of different factors that might be expected to have some influence on the value of corn are studied next in order to determine their influence on the value of corn. Some of these factors are suggested by the studies made by other workers in the field (2, 6, 7). Others are selected on a purely *a priori* basis. They are listed in table II.

A study of these factors by means of the graphic method of correlation analysis reveals very little relationship on the part of any of them, as far as the pre-war period is concerned. The

TABLE II. POSSIBLE FACTORS AFFECTING THE DECEMBER VALUE OF CORN

1. Quality of the corn crop.
2. Percentage of corn crop merchantable.
3. Corn production $\frac{39 \text{ "other" states}}{9 \text{ Corn Belt states}}$
4. Corn production $\frac{45 \text{ "other" states}}{3 \text{ Corn Belt states}} \frac{6 \text{ western states}}{\text{"other" states}}$
5. Corn production $\frac{6 \text{ western states}}{\text{"other" states}}$
6. United States oats production.
7. Chicago December oats price.
8. Hogs on farms Jan. 1 (next year).
9. Chicago December hog values.
10. All cattle on farms Jan. 1 (next year).
11. Livestock on farms Jan. 1 (next year).
12. September corn-hog price ratio.
13. Kansas City December wheat value.
14. United States November industrial production.

two variables that show most influence are the numbers of hogs on farms Jan. 1, and the December value of hogs, but even their relationship is slight.

Further study by numerical correlation methods provides a numerical measure of the influence of these variables. The betas or standard regression coefficients for corn production, the numbers of hogs on farms, and the December value of hogs, are shown in table III. These coefficients measure the relative influence of the three variables. They show that the influence of the two hog variables is very weak. When total livestock numbers (with the different kinds of livestock weighted by a figure representing their importance as consumers of corn) (10) are used instead of hog numbers the relationship is still weaker.

TABLE III. RELATION BETWEEN UNITED STATES AVERAGE FARM VALUE OF CORN AND FOUR INDEPENDENT VARIABLES. PREWAR PERIOD, 1899 TO 1915.

Table shows multiple correlation and standard regression coefficients for three combinations of factors. Bold faced figures indicate statistically significant values.

Independent variable	Standard partial regression coefficients		
	ABD	AC	ACD
U. S. corn production (A)	-1.0059	-.9788	-.9718
Numbers of hogs on farms Jan. 1 (C)	.1300	-----	-----
Numbers of livestock on farms Jan. 1 (C)	-----	.0235	.0449
December hog values (D)	.0869	-----	.0422
Multiple correlation coefficients	.9781	.9741	.9747

There is some relationship between fluctuations in the two hog variables and the residual fluctuation in corn values unexplained by changes in corn production, but it is too slight to be statistically significant. R. A. Fisher uses t to test the significance of a beta (4). The value of t is found by dividing a beta by its standard deviation. The values of t for the two hog variables, the coefficients for which are shown in column 2, are not statistically significant. For hog numbers, t is 1.57; for hog values, it is 1.23. The lowest value that could be considered significant is 2.160 (16). This means that the relationship shown may have been entirely the result of chance.

It might have been expected that the size of the oat crop would influence the value of corn. Both crops are used for feed. When oats are plentiful, more of them are fed, thus displacing some of the demand for corn; conversely when oats are scarce. The scatter diagrams for oat production, however, indicate that the size of the oat crop has practically no influence upon corn values.

The December price of oats at Chicago shows a slight influence. But since the influence of oat production is almost zero, the slight positive correlation between corn and oat prices must show the effect of the former on the latter, not vice versa. That is, the fluctuations in oat prices are a result, not a cause, of fluctuations in corn values. They are a dependent, not an independent variable.

The conclusion is reached, therefore, that before the war the United States December farm value of corn was determined almost entirely by the size of the United States corn crop. The numbers of hogs on farms, and the value of hogs (the series used to represent the latter being the December value of hogs at Chicago) have a slight influence, but it is not large enough to be statistically significant. The other variables which have been considered have practically no influence.

POST-WAR PERIOD

For the post-war period, the situation is different. The size of the corn crop is a much less complete explanation of the value of corn in the post-war period than in the pre-war period; other factors show more relationship with corn values than they did before the war. Estimates based on pre-war regressions would have gone astray after the war.

Inspection of figure 4B shows that the chief reason for the lower correlation between corn production and corn value after the war is the low value of corn in 1925 and 1926. In these two years the numbers of hogs on farms were also low. This suggests that hog numbers may have more influence after the war than they did before it. Further inspection shows that the variations not explained by crop size and hog numbers are largely explained by fluctuations in what is henceforth referred to as the west-east corn production ratio. This ratio shows the relative production of corn west and east of the Mississippi; it is obtained by dividing corn production in the six Corn Belt states west of the Mississippi (Iowa, Nebraska, Missouri, Kansas, Minnesota and South Dakota) by corn production in the other 42 states. Cox (2) found that this variable was the second most important factor affecting the average value of corn from November to June at Chicago. When this ratio is low, that is, when corn production west of the Mississippi is relatively low, the value of corn is depressed.

A word of caution should be spoken regarding the west-east corn ratio. Most of its correlation with corn values since the war is the result of the situation in 1926, when the ratio stood

16.8 percent below average (a record low since 1899). This coincides with a low value for corn in 1926. But in December, 1926, another influence was also at work. The visible supply of corn was the largest on record, nearly twice as large as in any previous December. This by itself might not have affected the value of corn; but in addition, a large amount of the corn in store at Chicago was being posted as out of condition, and this adversely affected the value of warehouse certificates (5). A part—perhaps most—of the low value in 1926 should be charged to this factor, rather than to the west-east corn production ratio. A conclusive decision concerning these two factors cannot be made until more time has elapsed.

The residuals left unexplained by the west-east corn production ratio are largely accounted for by fluctuations in industrial production. (This index is published currently in the monthly Federal Reserve Bulletin). The index for November is used here, since it is the best estimate of industrial production available to corn traders in December. When business is active and industrial production is high, the value of corn is higher than when business is sluggish.

The graphs showing the steps by which these factors are isolated are shown in fig. 6. The heavy lines show the net regression of each variable. The light lines, connecting years in which the values of the next variable (in the sequence of charts) were equal, show how the heavy line should be drawn in. The standard regression coefficients obtained by numerical correlation methods are shown in table IV.⁵ These coefficients indicate that the three new factors together are now as important as the size of the corn crop alone. The regression coefficients shown are all statistically highly significant.

TABLE IV. RELATION BETWEEN UNITED STATES AVERAGE FARM VALUE OF CORN AND FOUR INDEPENDENT VARIABLES.
Post-war Period, 1922-1929.

Table shows multiple correlation and standard regression coefficients.

Independent variable	Standard partial regression coefficients
United States corn production (A).....	-1.0873
United States livestock numbers (C)....	.4826
West-east corn ratio (M).....	.4510
November industrial production (P)....	.3621
Multiple correlation coefficient.....	.9907

These regression coefficients can be made the basis of an equation for estimating the value of corn. An equation of this sort enables the investigator to see how closely the factors he has isolated explain the value of corn each year; it enables him also to locate years in which the estimates differ markedly from the actual values.

⁵Livestock numbers are used in place of hog numbers, finally; they yield results almost identical with hog numbers, and constitute a more comprehensive index of the demand for corn than hog numbers alone.

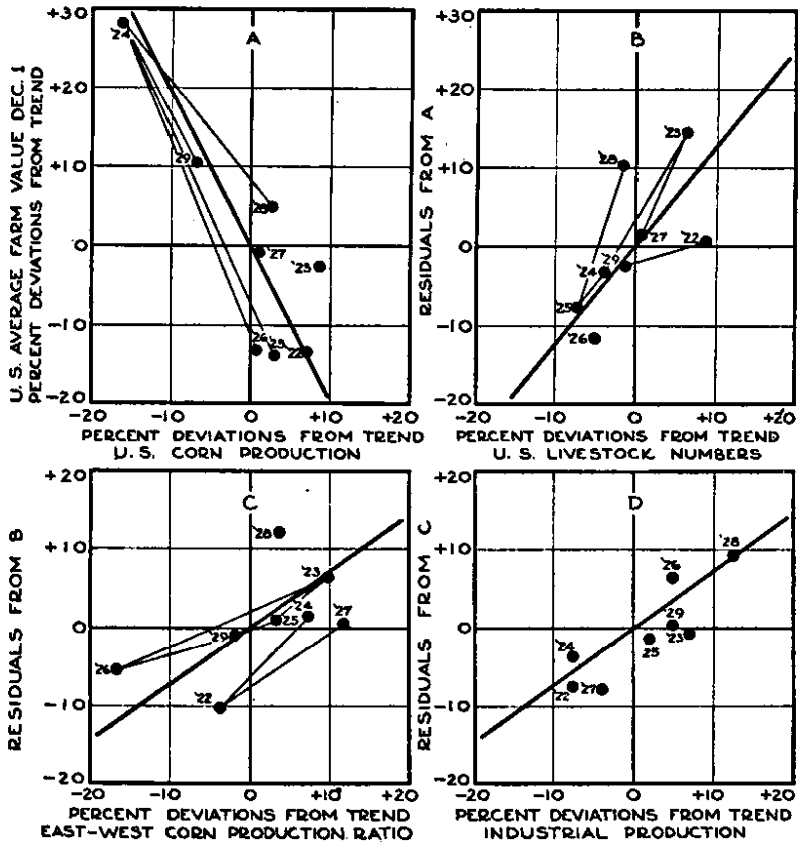


Fig. 6. Influence of United States corn production, hog numbers, west-east corn ratio, and Industrial production, upon the United States average farm value of corn, Dec. 1.

Estimates of the average farm value of corn, based on the size of the corn crop alone, are compared with the actual values in fig. 7. The estimates agree well with the actual values before the war, but poorly after the war. The agreement is especially poor from 1930 on.

Post-war estimates based on livestock numbers, the west-east corn ratio, and industrial production, as well as the size of the corn crop, however, agree fairly well with the actual values, except from 1930 on. They are represented by the dotted line in fig. 7. The data for the chart are shown in table V.

The divergence between the actual and estimated values in 1930, 1931 and 1932 calls for special comment. The actual value in 1930 was depressed chiefly by the low value of wheat, which kept the value of corn from rising as high as the short corn crop of 1930 would otherwise have carried it, and partly

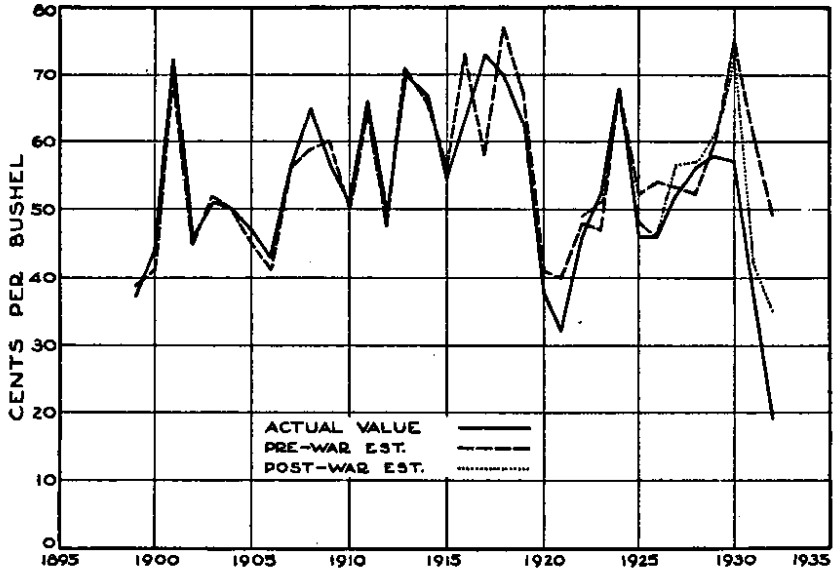


Fig. 7. Actual and estimated average farm value of corn Dec. 1.

by the steady decline in the general price level that started in 1929.

By 1931 and 1932 the value of corn was markedly depressed by the decline in the general price level. It is well known that when the general price level falls, the transportation, manufacturing and handling margins intervening between raw materials and finished goods do not decline proportionately; the prices of raw materials, therefore, fall farther than the general price level. Corn is a raw material that shows this effect very markedly.

This is not the first time that the trend of the value of corn has been depressed by a fall in the general price level. The deflation associated with the post-war depression of 1920 and 1921 stopped the rise in the trend of corn values that had persisted up to that time, and shifted the trend down to a new low level, at which it remained until 1929. This is clearly shown in fig. 1. Perhaps the same thing is being repeated at the present time; the whole trend of corn values seems to be shifting downward again. The new trend will probably run higher than corn values at the present time, but lower than the trend from 1922 to 1929, unless the general price level rises substantially or corn production is controlled.

The conclusions concerning the factors affecting the United States average farm price of corn can be summed up thus:

1. Before the war, the average farm value of corn was determined almost entirely by the size of the United States corn crop.

2. Since the war, the farm value of corn has become sensitive to other influences besides the size of the corn crop. Three other factors now seem to influence the value of corn—the numbers of livestock on farms, the rate of industrial production, and perhaps the west-east corn production ratio. The period since the war is so short, however, that these conclusions must be regarded as tentative.

3. The sudden and drastic decline in the general price level in 1920 shifted the short-time trend of corn values downward after the World War. The decline in the price level that started in 1929 appears to be shifting the trend still lower at the present time, though there will probably be some recovery from present extremely low corn values.

TABLE V. ACTUAL AND ESTIMATED AVERAGE FARM VALUE OF CORN DEC. 1

Estimates in column 3 based on factor A, with its pre-war regression coefficient shown in column 2, table III. Estimates in column 5 based on factors A, C, M and P, with their post-war coefficients shown in table IV.

1	2 Actual value	3 Estimated value based on pre-war regressions	4 Errors of estimate, Column 2 minus column 3	5 Estimated value based on post-war regressions	6 Errors of estimate, Column 2 minus column 5
1909	37	39	-2		
1900	44	41	+3		
1901	72	71	+1		
1902	46	45	+1		
1903	51	52	-1		
1904	50	50	0		
1905	47	45	+2		
1906	43	41	+2		
1907	56	56	0		
1908	65	59	+6		
1909	57	60	-3		
1910	51	50	+1		
1911	66	64	+2		
1912	49	48	+1		
1913	70	70	0		
1914	67	66	+1		
1915	54	56	-2		
1916	63	73	-10		
1917	73	58	+15		
1918	70	77	-7		
1919	63	68	-5		
1920	39	41	-2		
1921	32	40	-8		
1922	46	48	-2	47	-1
1923	52	47	+5	49	+3
1924	68	68	0	67	+1
1925	46	52	-6	47	-1
1926	46	54	-8	44	+2
1927	52	53	-1	55	-3
1928	56	52	+4	56	+1
1929	58	60	-2	61	-3
1930	57	75	-18	73	-16
1931	37	61	-24	42	-5
1932	19	49	-30	33	-14

ANNUAL FLUCTUATIONS IN THE IOWA DEC. 1 FARM VALUE
OF CORN
FOR THE STATE AS A WHOLE

The United States farm price of corn used in the preceding section is computed by averaging the farm prices for all the

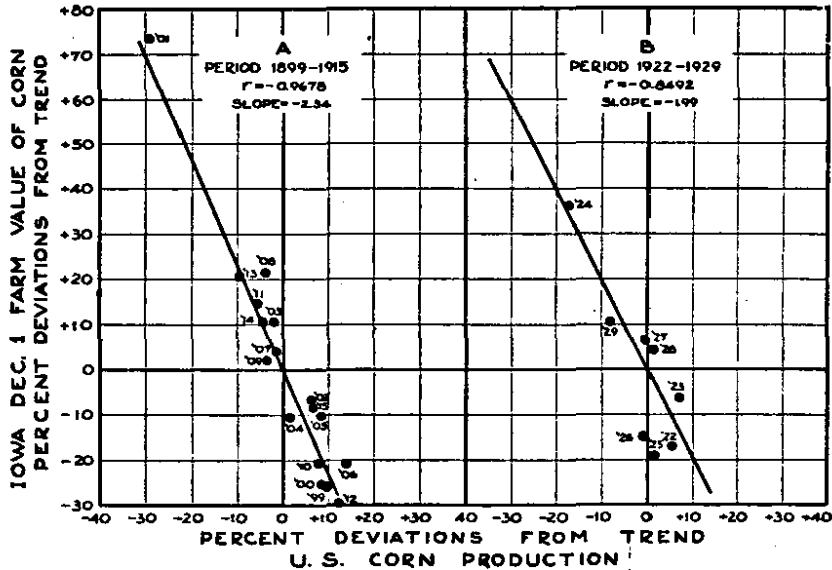


Fig. 8. Relation between U. S. corn production and Iowa Dec. 1 farm value of corn.

states of the Union. More information can be gained from a study of prices in a more restricted area representative of surplus conditions. For this purpose, Iowa, the heaviest corn producing state, is chosen.

The relation between the size of the United States corn crop and the value of Iowa corn at the farm Dec. 1 is shown in fig. 8. The chart is based on the same periods of years, 1899 to 1915 and 1922 to 1929, inclusive, that were used in the United States farm value section.

Comparison of this chart with the chart for the United States values shows that the Iowa farm value of corn fluctuates more than does the United States farm value of corn. The regression of Iowa corn values on United States corn production is -2.34 , while the regression of United States corn values is -1.62 . The pre-war relationship is almost as close as for the United States data; the correlation coefficient is -0.9678 for Iowa, compared with -0.9738 for the United States. The post-war regression line for Iowa is less steeply sloped than the pre-war line, as was the case with United States values. These coefficients are summarized in table VI.

TABLE VI. REGRESSION OF THE DEC. 1 FARM VALUE OF CORN UPON UNITED STATES CORN PRODUCTION.
Periods 1899-1915 and 1922-1929

Average farm value of corn	Regression coefficients	
	1899-1915	1922-1929
United States	-1.62	-1.54
Iowa	-2.34	-1.99

The Iowa farm value of corn fluctuates more than United States farm values for two reasons. Figure 9 shows, first, that the Iowa value series runs along at a lower level than the United States series. The *proportional* fluctuations in the Iowa series, then, would be the greater, even if the *absolute* fluctuations were the same. Figure 9 shows, secondly, however, that even the absolute fluctuations in the United States series are less than those of the Iowa series. The reason for this is that the United States series includes prices for states like Georgia which consume more corn than they raise. In such states the price of corn behaves more like the prices of consumption goods; it is relatively stable. This makes the United States price of corn absolutely, as well as proportionally, more stable than the Iowa price.

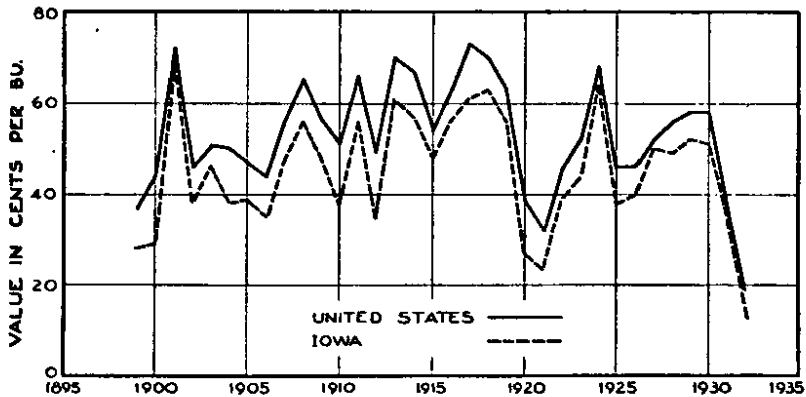


Fig. 9. Average farm value of corn Dec. 1, for the United States and for Iowa.

FOR IOWA DISTRICTS 4, 5 AND 6

Although Iowa is a surplus corn producing state, considered as a whole, there are corn deficit areas within the state. It is worth while to investigate whether farm prices in one homogeneous surplus area fluctuate differently from those in one homogeneous deficit area.

Iowa is divided into nine crop reporting districts. These districts are shown in fig. 10. The heart of the heaviest surplus corn area in the state is located at about the point where districts 1, 2, 4 and 5 meet. The most important deficit area is District No. 6 in the eastern part of the state.

It is difficult to decide which of the four districts, 1, 2, 4 and 5, is the most representative of the corn surplus area. Perhaps the best plan is to take districts 4, 5 and 6 as representing the change from surplus at the one end to deficit at the other, studying each of the three districts in turn.

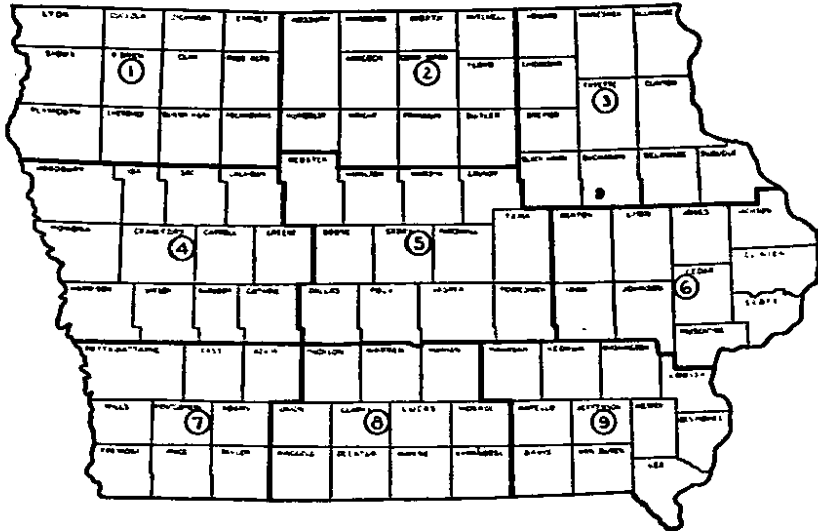


Fig. 10. Iowa crop reporting districts.

Unfortunately, the original price data by districts run back only as far as 1909. The pre-war period is only 7 years long. The results of a study of the district prices, therefore, cannot be compared directly with the results already found for Iowa values, because the Iowa results were based on the period from 1899 to 1915. The district price results must be compared with a new study of Iowa prices based on the short period from 1909 to 1915, inclusive. For the purposes of this comparison, nothing would be gained by reducing the corn prices to values, for this would simply divide all the different corn price series by the same common denominator (the index of the general price level). The corn price data are therefore compared directly, without first being converted to values.

The price data for the different districts⁶ are shown plotted in a time chart in fig. 11.

District No. 4 is the heaviest surplus area of the three districts chosen. During the pre-war period, its prices generally ranged lower than those in the other districts. During the war, however, and since 1923, the prices for district No. 4 have shown a tendency to run higher in relation to the prices in the other districts than before the war. The prices for District No. 5, in the middle of the state, now range lower than the prices for any other district. Corn has been moving westward from the western part of Iowa during the last few years, owing

⁶The original listing and summary price sheets for Iowa were secured from the Bureau of Agricultural Economics at Washington, through the courtesy of Mr. Roger Hale of that bureau.

The averages for each district after 1924 were already computed on summary sheets that came with the original data. The district averages for the years before 1924 were not thus computed and were accordingly worked out in this office.

to increased demand from western states; the lowest price area has shifted from western Iowa to central Iowa. The difference between the prices in the different districts, however, is a matter of only a few cents.

The correlation coefficients and the regression of price on (United States) corn production for each district are shown in table VII.

TABLE VII. CORRELATION COEFFICIENTS AND REGRESSION OF THE DEC. 1 FARM PRICE OF CORN UPON UNITED STATES CORN PRODUCTION.
Period 1909 to 1916.

Average farm price of corn	Correlation coefficient	Regression
Iowa	-.9643	-2.09
District No. 6.....	-.9692	-1.89
District No. 5.....	-.9033	-2.05
District No. 4.....	-.8735	-2.11

District No. 6, the deficit area, shows the highest correlation coefficient and the lowest regression. Districts 5 and 4 show progressively lower correlation coefficients and higher regressions. The uniform increase in the regression with the increasing distance from Chicago and with the transition from deficit to surplus areas accords with the reasoning given in the preceding section.

The reason why the correlation coefficients decrease with increasing distance west from Chicago is that the price in any district is affected by the size of the corn crop in that district as well as by the size of the corn crop in the entire United

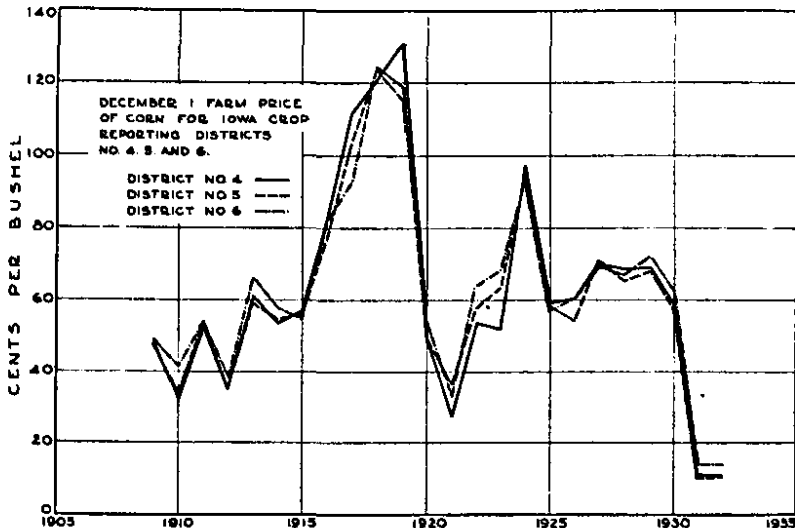


Fig. 11. Dec. 1 farm price of corn for Iowa crop reporting districts Nos. 4, 5 and 6.

States. Toward the western edge of the Corn Belt the size of the corn crop does not fluctuate closely in line with fluctuations in the size of the crop for the United States as a whole. In the western part, rainfall is the limiting factor; but in the rest of the United States, temperature, length of season, etc., affect the yield also. The farther west one goes, the lower is the correlation between the local yield and the average United States yield of corn; and the lower is the correlation between the local price and the size of the United States corn crop.

This analysis is based on the pre-war period from 1909 to 1915, inclusive. Somewhat different results would be obtained from a study of the post-war period, because the relation of the price of District No. 4 to the prices of other districts has changed somewhat since the war. The differences, however, would not be great, and calculations for the post-war period accordingly are not made.

ANNUAL FLUCTUATIONS IN CORN VALUES AT CHICAGO

INFLUENCE OF FLUCTUATIONS IN CORN PRODUCTION PRE-WAR PERIOD

The preceding sections have dealt with annual fluctuations in the price of corn at the farm. This study should be supplemented by a similar study of corn prices at the leading corn market, Chicago. Corn prices at Chicago are more concrete and tangible than average farm prices. They are more quickly and easily available in current reports, and relate to one specific grade of corn at one specific market. The results of a study of Chicago prices may have more useful applications than those of a study of farm prices; one cannot buy and sell corn on the "United States average farm" market, but he can on the Chicago market.

The present section, therefore, will deal with fluctuations in the price of corn at Chicago. It will be restricted to a study of December prices. By December the final estimates of the corn crop have been reported, and the influence of the most important factor has manifested itself in the market. The prices used in this analysis are first reduced to values by division by the Bureau of Labor Statistics index of the general price level for the corresponding December.

The movements of these December Chicago corn values are similar to those of the United States average Dec. 1 farm values considered in the preceding section. Figure 12 shows the two series plotted on the same time chart. The chart shows the occasional differences between the fluctuations in the two series, as well as their general similarity.

A scatter diagram showing the relation of the annual fluctuations in corn production to the fluctuations in Chicago Decem-

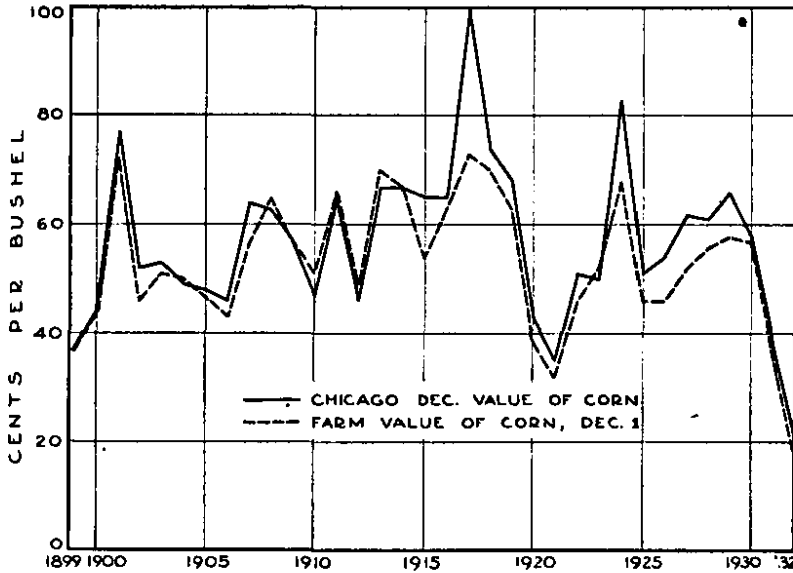


Fig. 12. U. S. average Dec. 1 farm value of corn and Chicago December value of corn.

ber corn values is shown in fig. 13A. The regression line in the chart shows the regression of Y on X, derived by the usual

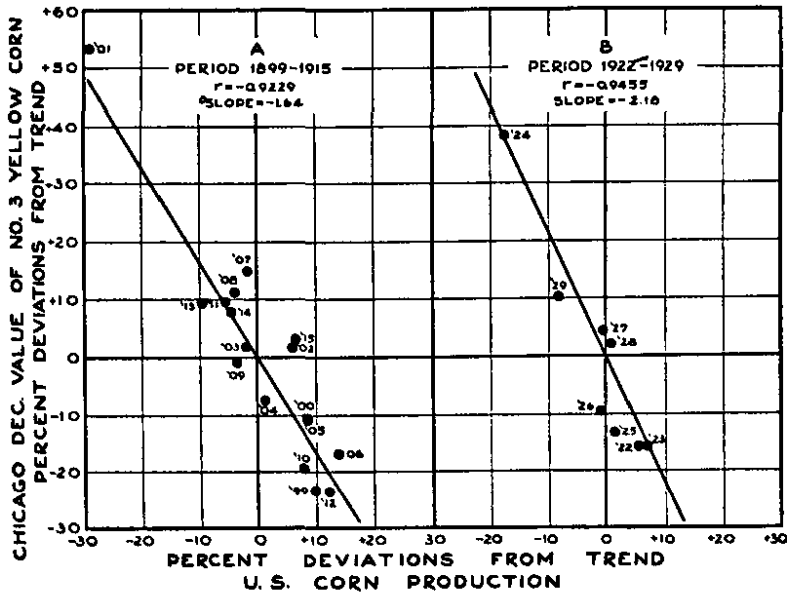


Fig. 13. Relationship between U. S. corn production and Chicago December value of corn, 1899-1915.

formula. The correlation coefficient is $-.9229$. This is lower than the coefficient for farm values, which was $-.9738$.

The regression of Chicago values on United States corn production is -1.64 . This is practically the same as -1.62 , the regression of United States farm values on production.

POST-WAR PERIOD

The data for the post-war period are shown plotted in a scatter diagram in fig. 13B. The chart shows that the regression of value on production has increased since the war. It has risen from -1.64 to -2.22 .

OTHER FACTORS AFFECTING THE DECEMBER VALUE OF CORN AT CHICAGO

PRE-WAR PERIOD

A graphic correlation study of the various other factors that might affect the December value of corn at Chicago shows that the most important variables are three in number.

First, after the overwhelming influence of the size of the corn crop has been removed, comes the quality of the corn crop. The regression of Chicago corn value on the quality of the corn crop is negative. The reason for this is that this study deals with the value at Chicago of a comparatively high grade of corn, No. 3 Yellow. When the quality of the corn crop is low, there is a scarcity of high grade corn on the market. The value of No. 3 corn is therefore higher than when the quality of the corn crop is good.

In addition, the numbers of livestock on farms show some relationship.⁷ The regression of this variable is positive; large numbers of livestock create a strong demand for corn, and this raises the value of corn.

The regressions are all linear. The scatter diagrams showing the steps by which they are derived are shown in fig. 14. Each chart is based upon the residuals from the preceding chart. The light lines connect years in which the values of the next variable are nearly equal. The heavy lines are given the same slope as the light lines; they represent lines of net regression.

The December value of hogs at Chicago shows a slight positive regression, but it is too slight to be significant.

Apparently it takes a somewhat long-time rise or fall in the value of hogs to affect corn values; changes in the *trend* of hog values have a compelling influence on the *trend* of corn values, as fig. 15 shows. A change in the trend of livestock values will induce feeders to pay more or less for corn. But a short-time, temporary rise may turn into a decline before the

⁷Either livestock numbers or hog numbers can be used; the results throughout are practically identical. The livestock index is more comprehensive than hog numbers alone, however, so it is used rather than hog numbers alone.

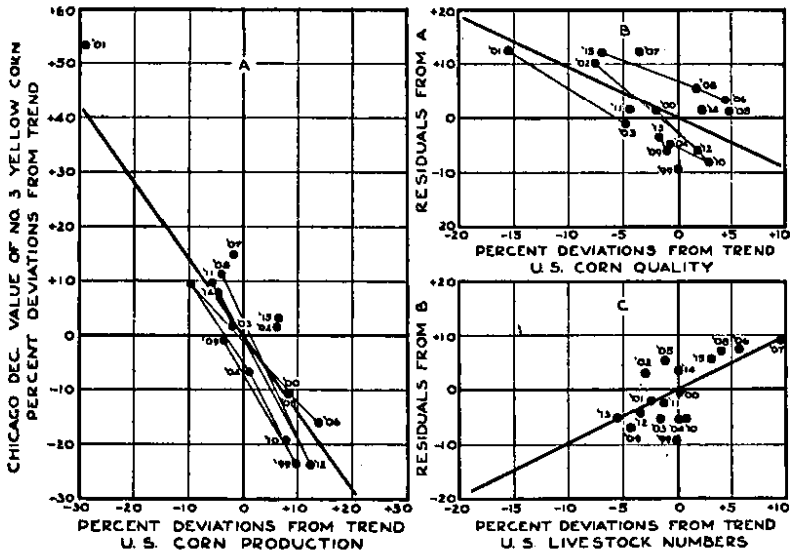


Fig. 14. Regression of the December value of No. 3 Yellow corn at Chicago upon U. S. corn production, corn crop quality and U. S. livestock numbers.

livestock is marketed; it accordingly does not have much effect on the price that feeders will pay for corn.

Oat production, here as in the section dealing with corn values at the farm, is shown to have practically no influence on corn values. This agrees with the results obtained by R. W. Cox in his study of average Chicago corn values from November to June each year (2). The December value of oats at Chicago shows some positive correlation with corn values, but

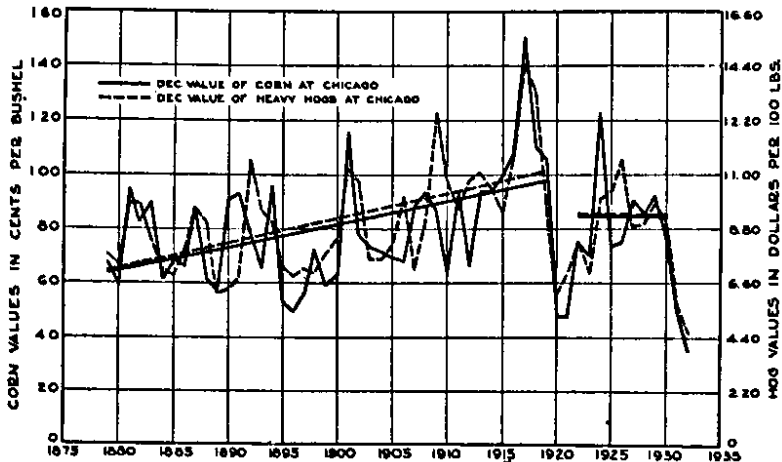


Fig. 15. The trend of corn values compared with the trend of hog values.

since oat production shows no relationship, this means only that corn values influence oat values, not vice versa. That is, fluctuations in oat values are a result, not a cause, of fluctuations in corn values.

The December value of wheat appears to have very little influence on the value of corn. There is ordinarily a close sympathetic relation between daily and sometimes weekly fluctuations in wheat and corn prices, but not much between the movements for longer periods.

During 1930, low wheat values depressed corn values for several months. But this was because wheat values were depressed by world conditions at the same time that corn values were raised by the effect of a short corn crop until they equalled wheat values. The two grains are almost equally good for feed. When wheat is as cheap as corn, therefore, a decline in the value of wheat will immediately depress the value of corn. But when wheat is considerably higher than corn—as it usually is—it makes little difference whether it is 60 percent higher or only 40 percent. It will not be fed in either case.

A numerical multiple correlation study, using the December value of corn as the dependent variable, and the three factors isolated by the graphic method—corn production, the quality of the corn crop and the numbers of livestock on farms—yields the coefficients shown in column 3 of table VIII. The relative importance of the three factors is shown by the size of their standard partial regression coefficients.

TABLE VIII. RELATION BETWEEN CHICAGO DECEMBER CORN VALUE AND FIVE INDEPENDENT VARIABLES.

Pre-war Period, 1899-1915; Post-war Period, 1922-1929.

Independent variable	Pre-war period			Post-war period	
U. S. corn production (A).....	-.9229	-.7539	-.7975	1.0046	-.9354
Corn crop quality (B).....		-.2578	-.2565	-.0586	-.2076
Numbers of livestock on farms, Jan. 1 (C)1990	.2061	.3032
November industrial production (D)2466
West-east corn production ratio (M)2400
Multiple correlation coefficient.....		.9423	.9630	.9606	.9807

Figure 16 shows the actual value of corn compared with estimates made by the use of a regression equation based on the coefficients given above. The standard deviations for the pre-war period are used throughout. (See table IX.)

Figure 16 shows the estimates extended through the years after 1915. The application of the estimating equation to the period after 1915 is a test of the stability of the pre-war regressions. For the pre-war B's are used through the war and post-war period as well as in the pre-war years.

The chart shows that the estimates seldom agree exactly with the actual values. Before the war the differences are never very large; the average difference for the pre-war period is 1.88 cents. But wide divergencies occur in some of the years

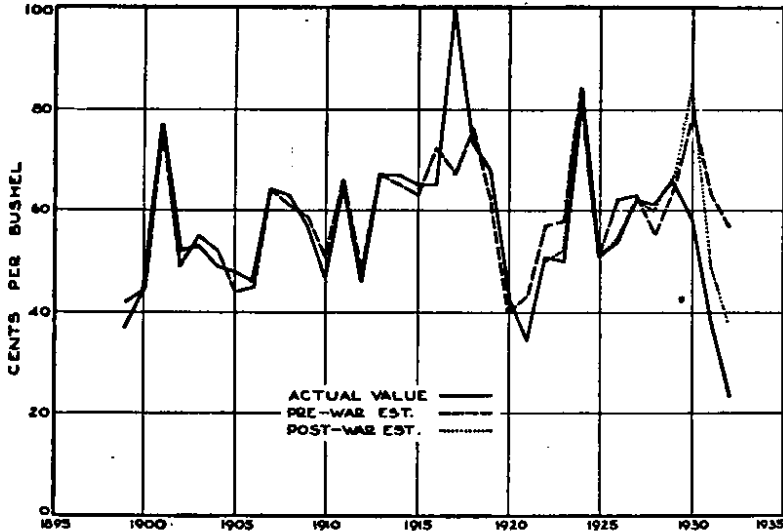


Fig. 16. Actual and estimated Chicago December values of No. 3 Yellow corn.

after 1915. These differences mean that war-time influences either changed the old regressions, or brought in new factors.

WAR PERIOD

In spite of the abnormal nature of the war period, the estimated corn values during the war missed the mark by a wide margin only once, in 1917. In that year, the actual value exceeded the estimate by 33 cents. The reason for this appears to have been the extreme rise in the value of hogs which took place at that time. This high value of hogs was, in turn, the result of the great increase in demand for pork resulting from the war; pork exports in 1916 and 1917 jumped 50 percent above the pre-war figures (13). This increased foreign demand for military purposes was augmented by our own when we entered the war in 1917. From December 1916 to December 1917, the value of hogs increased more than 50 percent (15). The value of corn went up with it.

Speculation, prohibited in wheat futures from Aug. 27, 1917, to July 15, 1920, ran wild in corn futures. The movement was largely confined to Chicago; fig. 12 shows that the United States average farm value of corn rose much less than Chicago values did. By 1918, however, the speculative excitement had subsided. The actual value of corn in 1918 was, in fact, 4 cents below the estimate.

During the rest of the war years, the estimates agree reasonably well with the actual corn values.

POST-WAR PERIOD

The estimates do not agree very closely with the actual corn values after the war. The differences are especially wide from 1930 to 1932.

TABLE IX. ACTUAL AND ESTIMATED VALUES OF NO. 3 YELLOW CORN IN DECEMBER AT CHICAGO.

Estimates in column 3 based on factors A, B and C with their pre-war coefficients shown in column 4 of table VIII. Estimates in column 5 based on factors A, B, C, P and M with their post-war coefficients shown in column 6 of table VIII.

1	2 Actual value	3 Estimated value based on pre-war regressions	4 Errors of estimate. Column 2 minus column 3	5 Estimated value based on post-war regressions	6 Errors of estimate. Column 2 minus Column 5
1899	37	42	-5		
1900	44	44	0		
1901	77	77	0		
1902	52	49	+3		
1903	53	55	-2		
1904	49	52	-3		
1905	48	44	+4		
1906	46	45	+1		
1907	64	64	0		
1908	63	61	+2		
1909	57	59	-2		
1910	47	51	-4		
1911	65	66	-1		
1912	46	47	-1		
1913	67	67	0		
1914	67	65	+2		
1915	65	63	+2		
1916	65	72	-7		
1917	100	67	+33		
1918	74	76	-2		
1919	68	62	+6		
1920	43	40	+3		
1921	35	43	-8		
1922	51	57	-6	50	-1
1923	50	58	-8	52	-2
1924	83	84	-1	83	0
1925	51	51	0	51	0
1926	54	62	-8	55	-1
1927	62	63	-1	62	0
1928	61	55	+6	60	+1
1929	66	64	+2	67	-1
1930	58	79	-21	85	-27
1931	38	63	-25	49	-11
1932	23	57	-34	38	-15

These were years when business activity was low. This fact furnishes a clue to the reason for the differences that occur, not only in those years, but in the other post-war years. If the differences for the years from 1922 to 1932 are plotted against an index of industrial production (the same index used earlier in this bulletin) a strong positive regression is revealed.⁹

When business activity is included in the multiple regression equation for the post-war period, the estimates come into closer agreement with the actual corn values, but some scatter still remains. The most noticeable discrepancy occurs in 1926, when the estimate is about 10 cents too low.

It will be recalled that the estimate for 1926 was too low in the farm value section, also, until the distribution of corn pro-

⁹Corn values before the war show practically no regression on industrial production, partly because the Federal Reserve index of industrial production is not available before the war (the index of business activity compiled by the Cleveland Trust Company is used instead, and it is not strictly comparable with the Federal Reserve index) and partly because the fluctuations in industrial production before the war were not so violent as they have been since the war.

duction west and east of the Mississippi was taken into account. Possibly this west-east corn ratio has come to exert an influence on Chicago corn values, as well as on farm values, since the war. It is accordingly added as a fifth variable to the four others already included. The successive scatter diagrams are shown in fig. 17.⁹

When these five factors are included in a numerical multiple correlation study of the post-war period, the coefficients shown in column 6 of table IX are obtained. The post-war period is so short that these coefficients should be regarded as only tentative.

Estimates of Chicago December corn values from 1922 to 1929, inclusive, made on the basis of the post-war coefficients for corn production, corn quality, livestock numbers, industrial production and the west-east corn ratio are represented by the dotted line in fig. 16.

The agreement between the estimated and actual values is about as close after the war as before it, except for the years 1930, 1931 and 1932. During those years the actual values run from 11 to 27 cents below the estimated values. This indicates that the trend of corn values may be shifting downward again, as it did during the depression of 1920.

The conclusions of this study of Chicago December corn values can be summed up in a few paragraphs:

1. Before the World War, fluctuations in the December value of corn were largely explained by the action of three factors—the size of the corn crop, the quality of the crop and the numbers of livestock on farms.

2. Since the war, the Chicago December value of corn has become responsive to one or two additional factors; these are (a) industrial production and perhaps (b) the west-east corn production ratio.

3. The regression of Chicago corn value on United States corn production before the war was -1.64 . Since the war, it has increased to -2.22 .

4. The drastic decline in the general price level in 1920 shifted the short-time trend of Chicago corn values downward. The decline in the price level that started in 1929 appears to be shifting the trend still lower at the present time. Unless a substantial rise in the general price level takes place, the trend of corn values in the future will probably be considerably higher than corn values at the present time, but lower than the trend from 1922 to 1929.

⁹The word of caution concerning the west-east corn ratio that was spoken in the farm value section should be repeated here. Most of the regression of this factor is the result of its extremely low value in 1928 coinciding with the large minus residual shown for that year in fig. 17. This coincidence may have been accidental, not casual; it was shown earlier that corn values in 1928 may have been depressed by a combination of high visible supplies and an accumulation of out-of-condition corn in Chicago, and not by the west-east corn ratio. This possibility is strengthened by the fact that no very satisfactory reason has yet been given why the west-east corn ratio should have any effect on the value of corn at the farm or at Chicago.

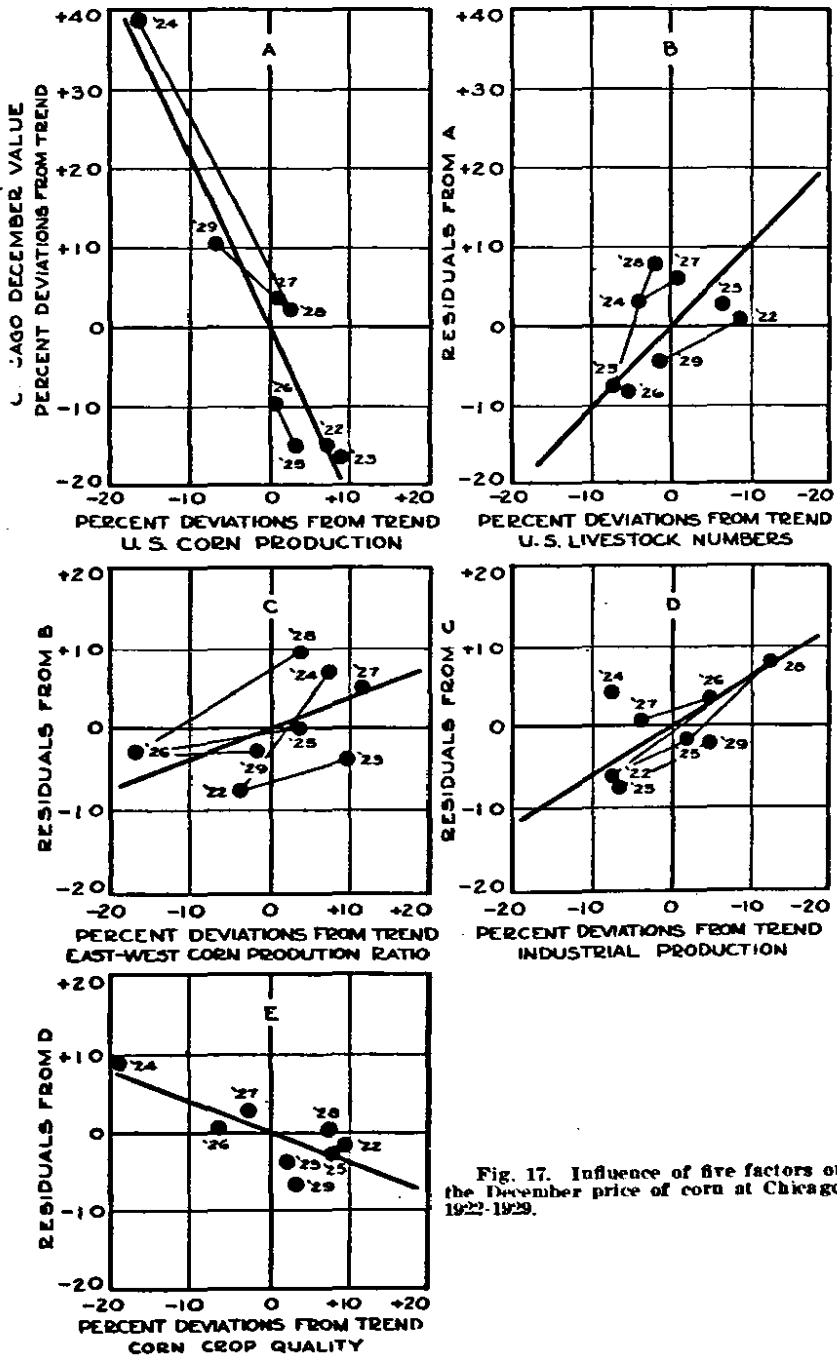


Fig. 17. Influence of five factors on the December price of corn at Chicago, 1922-1929.

GENERAL CONCLUSIONS

Anyone attempting to estimate December corn values in advance during the post-war period (even if he could have worked out accurate preliminary estimates of certain factors such as livestock numbers, which are not available until after December) would not have fared very well. After the war, the pre-war relationships changed somewhat, and additional factors came into play. Neither of these things would have been foreseen, and estimates based on pre-war relationships would have missed the mark rather widely and rather often, as fig. 16 shows.

If by 1929 the investigator had worked out the new post-war relationships and begun to make estimates on that basis, his estimates would have gone astray in 1930, 1931 and 1932. This also is shown in fig. 16.

The investigator would have had fair success in 1930, 1931 and 1932 if he had either (a) multiplied the index of the general price level by some figure higher than unity before dividing the price of corn by it, or (b) used a curved regression line for business activity—that is, had extended the line in fig. 17D downward and to the left, not in a straight line but in a line that curved downward.

There is small likelihood, however, that the investigator could have made either of these modifications with accuracy. The behavior of corn values during the post-war depression of 1920 is almost the only basis available for making such modifications, and it would not have been an adequate basis for estimates during the present depression. It would not have taken account of the peculiar circumstances in 1930, when the value of corn was depressed by extremely low wheat values. It would not have taken account of the depressing effect in 1931 and 1932 of extremely high European tariffs on lard and other hog products, which depressed hog and corn values further than estimates based on the behavior of corn values during the post-war depression would have indicated. And finally, it might lead the estimator astray in future years when business activity increases; for it is not at all certain that the regression of corn values on industrial production in times of industrial recovery *from* extremely low levels is the same as the regression when industrial production is declining *to* those low levels.

The inaccuracy of the estimates from 1920 to 1932 is an illustration of the limitations of correlation technique. It draws attention to the fact that the value of corn at any time is determined by two groups of influences, (a) those which recur every year; for example, changes in the size of the corn crop, and (b) those which happen but once and may not occur again, for instance, the extremely low price of wheat in 1930,

and the very high foreign tariffs against lard at the present time. A correlation analysis takes into account only the first group of influences or factors, and it is accurate only if the ascertained relations continue to hold. If the results of such a correlation study are followed blindly, they will do more harm than good.

But if the results of a correlation study are used for what they are—a means of estimating the effect of only the one group of factors, the recurring factors—they clear the way for a study of the effect of the second group. This secondary study may run in terms of what has been called the “informal statistical method” (1). This method involves using simple comparisons of the given situation with others having some resemblance to it. It calls for experience, good judgment and sound reasoning powers on the part of the investigator. The combination of these two methods, the first method paving the way for the use of the second, is more effective than either method used alone.

LITERATURE CITED

- (1) Advisory Committee on Economics and Social Research in Agriculture of the Social Science Research Council, Research method and procedure in agricultural economics. Vol. 1, p. 16.
- (2) Cox, Rex W., Factors influencing corn prices, Univ. of Minn. Agr. Exp. Sta. Tech. Bul. 81, 1931.
- (3) Ezekiel, Mordecai. Statistical analysis and the “laws” of price. Quarterly Jour. of Econ., February, 1928.
- (4) Fisher, R. A. Statistical methods for research workers. Oliver and Boyd, London. 1930.
- (5) Fitz, L. A., Chicago Grain Exchange Supervisor. Correspondence with the present writer.
- (6) Longstreet, Roy W. Unpublished studies. Purina Mills Co., St. Louis. 1929.
- (7) Metzger, Hutzler, Research method and procedure in agricultural economics, Social Science Research Council, Vol. 2; 288-297. 1928.
- (8) Mills, F. C., The behavior of prices, p. 53, National Bureau of Economic Research, Inc., New York, 1927. The prices to which Mills refers are Dec. 1 farm prices. Those at Chicago fluctuate similarly.
- (9) Schultz, Henry. The shifting demand for selected agricultural commodities, 1875-1929. Jour. of Farm Econ., April, 1932.
- (10) Shepherd, Geoffrey. The secular movement of corn prices, Iowa Agr. Exp. Sta. Res. Bul. No. 140. 1931.
- (11) Shepherd, Geoffrey. Prices, purchasing power, and value. Jour. of Farm Econ., July, 1932.
- (12) Smith, B. B. Jour. of the Amer. Stat. Assn. p. 543. December, 1925.
- (13) Statistics of hogs, pork, and pork products, U. S. D. A. Stat. Bul. No. 18, p. 87. 1927.
- (14) U. S. D. A. Corn statistics, Stat. Bul. No. 28. 1929.
- (15) U. S. D. A. Yearbook. p. 789. 1932.
- (16) Wallace, H. A., and Snedecor, G. W. Correlation and machine calculation. Iowa State College Off. Pub., p. 62. June 24, 1931.
- (17) Wicksteed, P. H. The common sense of political economy, Vol. 2: 506, George Routledge & Sons Ltd., London. 1933.