CHAPTER 3

Cyclic Variations in Individual Agricultural Prices

Under conditions of atomistic competition, the price and production of a commodity are determined at the point where the supply and demand curves intersect. Under static conditions a disturbance that moves the price and production from that intersection point sets in motion forces which tend to bring them back to the original point.

Where there is a considerable time lag in the response of production to a change in price, however, the price and production may not return to the original equilibrium point; instead, they may circulate around it.

A drouth, for example, which reduces the size of the corn crop, will raise the price of corn. Ordinarily, this induces farmers to raise fewer hogs. When those hogs reach the market the small size of the market receipts raises the price of hogs. This rise in the price of hogs induces farmers to raise more hogs; then when this large crop of hogs reaches the market, it depresses the price of hogs below

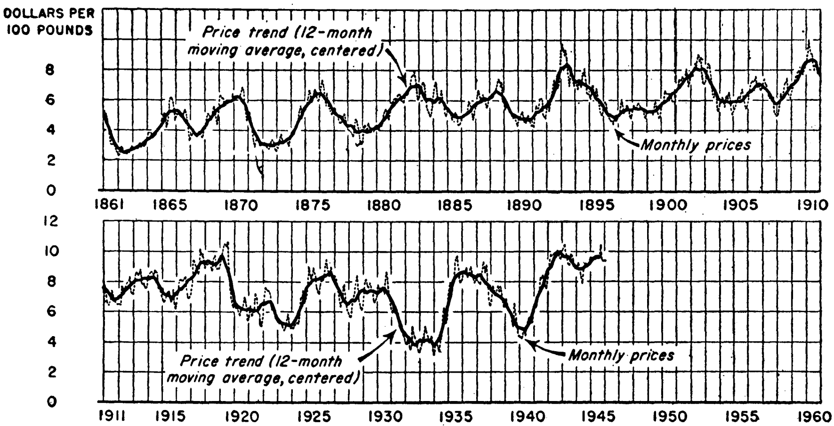


FIG. 9.—Cyclic changes in heavy hog prices at Chicago, 1861–1945, adjusted to 1909–14 prices level.

the equilibrium point. This leads farmers to produce fewer hogs, and so on. The price and production of hogs continues to swing round and round the equilibrium point rather than settle at it.

Figure 9 shows that this in fact is what actually takes place. The figure shows that the price of hogs in the United States moves in characteristic cycles averaging about four years in length. These cycles in hog prices are caused by opposite cycles in hog production.

The situation is shown in terms of supply and demand curves in the upper part of Figure 10.[1] The demand curve is represented by D_tD_t'. It shows the schedule of prices received for various quantities.

The supply curve is represented by S_tS_t'. It shows the quantities that farmers will produce in response to various prices. But these quantities do not reach the market until a production and marketing period has elapsed. OQ_1 is the quantity that sets the price in period 1 (the first crop-disposal year), but OQ_2 is the quantity produced in period 2 (the second crop-disposal year) in response to the price in period 1. These two quantities are by no means identical; they may be quite different, as they are in this case. The two curves shown in Figure 10 lie in two different planes reflecting two different time periods. They do not intersect; the one laps over the other.

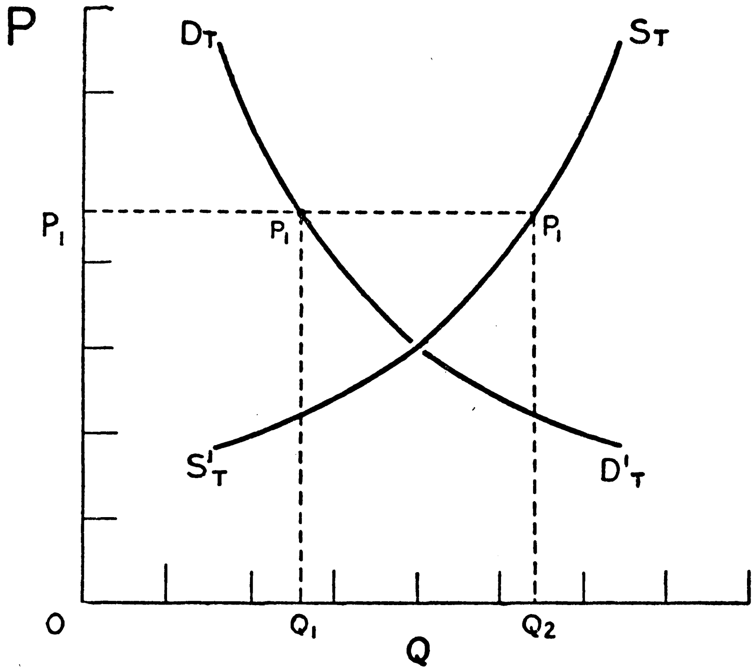
THE "COBWEB THEOREM"

This situation has been given a generalized explanation, referred to as the "cobweb theorem."

CASE 1: CONTINUOUS FLUCTUATION

In the lower portion of Figure 10, the series of reactions is portrayed for the curves shown in the upper portion of the figure. The quantity in the initial period (Q_1) is large, producing a relatively low price where it intersects the demand curve, at P_1. This low price, intersecting the supply curve, calls forth in the next period a relatively short supply, Q_2. This short supply intersects the supply curve at a high price point, P_2. This high price calls forth a corresponding increased production Q_3 in the third period, with a corresponding low price, P_3. Since this low price in the third period is identical with the original price in the first period, the production

[1] This figure and Figures 11, 12, 13, and 19 are reproduced from Mordecai Ezekiel, "The Cobweb Theorem," *Quarterly Journal of Economics,* LII, February, 1938. Part of the discussion is based on this excellent article.



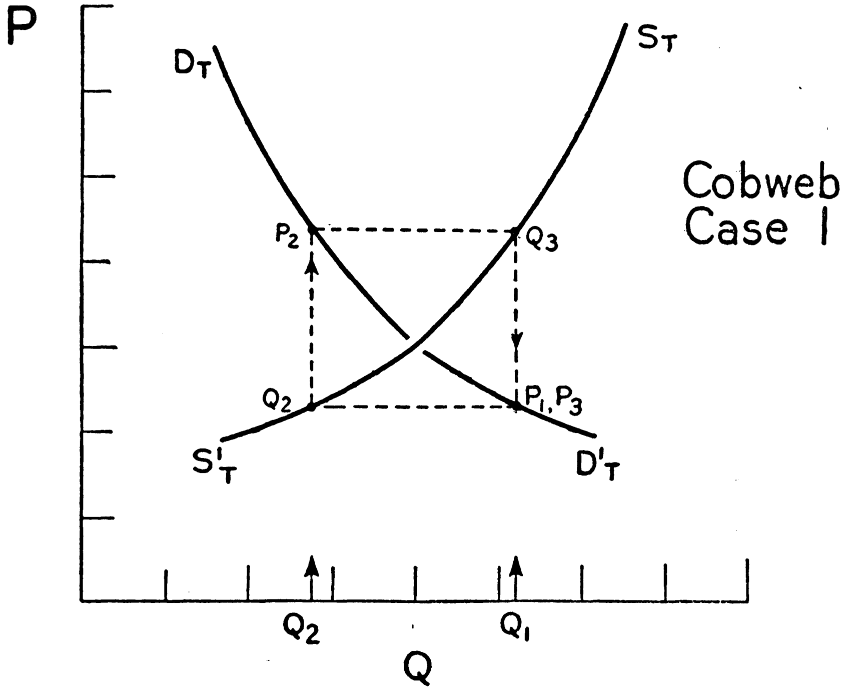


FIG. 10.—The mechanics of continuous cycles in prices and production. (From Ezekiel, *see* footnote 1, page 30.)

and price in the fourth, fifth, and subsequent periods will continue to rotate around the path Q_2, P_2, Q_3, P_3, etc.

As long as price is completely determined by the current supply, and supply is completely determined by the preceding price, fluctuation in price and production will continue in this unchanging pattern indefinitely, without an equilibrium being approached or reached. This is true in this particular case because the demand curve is the exact reverse of the supply curve, so that at their overlap each has the same elasticity. This is a case of "continuous fluctuation."

CASE 2: DIVERGENT FLUCTUATION

Where the elasticity of supply is greater than the elasticity of demand, the series of reactions works out as shown in the upper portion of Figure 11. Starting with the moderately large supply, Q_1, and the corresponding price, P_1, the series of reactions is traced by the dotted line. In the second period, there is a moderately reduced supply, Q_2, with the corresponding higher price, P_2. This high price calls forth a considerable increase in supply, Q_3, in the third period, with a resulting material reduction in price, to P_3. This is followed by a sharp reduction in quantity produced in the next period to Q_4, with a corresponding very high price, P_4. The fifth period sees a still greater expansion in supply to Q_5, and so on.

Under these conditions the situation might continue to grow more and more unstable, until price fell to absolute zero, or production was completely abandoned, or a limit was reached to available resources (where the elasticity of supply would change) so that production could no longer expand. This is a case of "divergent fluctuation."

CASE 3: CONVERGENT FLUCTUATION

The reverse situation, with supply less elastic than demand, is shown in the lower portion of Figure 11. Starting with a large supply and low price in the first period, P_1, there would be a very short supply and high price, Q_2, and P_2, in the second period. Production would expand again in the third period, to Q_3, but to a smaller production than that in the first period. This would set a moderately low price, P_3, in the third period, with a moderate reduction to Q_4 in the fourth period; and a moderately high price, P_4. Continuing through Q_5, P_5, and Q_6 and P_6, production and price approach more

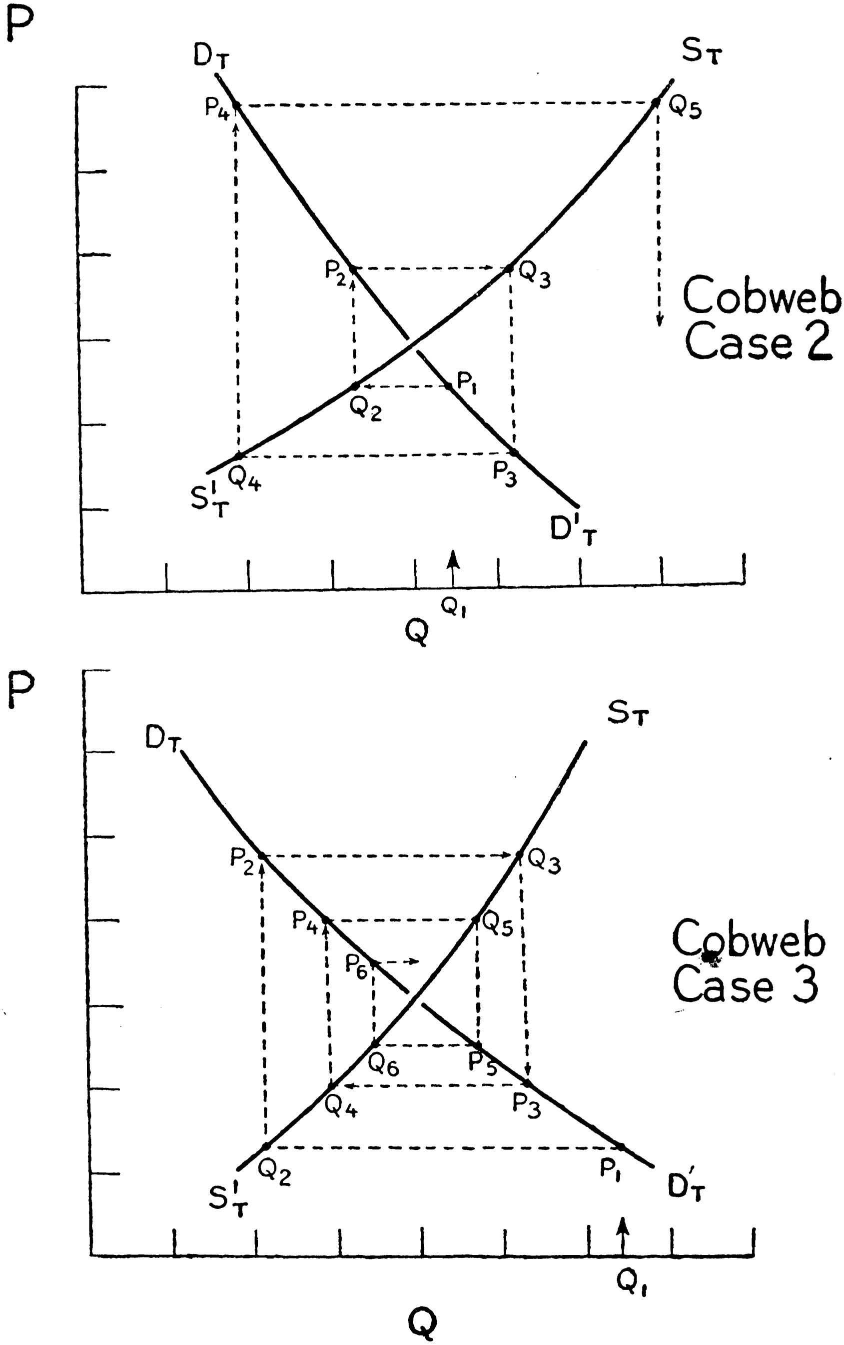


Fig. 11.—The mechanics of divergent and convergent cycles in prices and production. (From Ezekiel, *see* footnote 1, page 30.)

and more closely to the equilibrium condition where no further changes would occur.

Of the three cases considered thus far, only this one behaves in the manner assumed by equilibrium theory; and even it converges rapidly only if the supply curve is markedly less elastic than the demand curve. This is a case of "convergent fluctuation."

LONG CYCLES

The cobweb theorem as developed above explains two-year cycles in production and prices, alternating up one year and down the next. It does not fully explain the longer cycles observed for some commodities; that requires a further extension of the cobweb analysis.

In the cases considered thus far, it has been assumed that a change of price in one period was reflected in a corresponding change in production in the next succeeding period. In some commodities (such as hogs, beef cattle, apples, etc.) two or more seasons may be required for the production process, so that two or more periods may elapse before the effect of price upon production becomes apparent. If we assume that the effect of price upon production appears entirely in the second succeeding period, how will the "cobweb" work out? This further condition may be examined for any one of the three cases shown. The upper portion of Figure 12 shows it for Case 1. It may be regarded as Case 1a.

CASE 1A: TWO-PERIOD LAG IN SUPPLY, CONTINUOUS FLUCTUATION

Since two years are required for the result of the first year to appear, the supplies for the first two years, Q_1 and Q_2, must be assumed, with the resulting prices P_1 and P_2. In response to the initial low price, production two years later, in the third period, is reduced to Q_3, with the resulting high price, P_3. This is followed in the fifth year by a corresponding increase to Q_5, with a corresponding low price, P_5. Since this is a subclass of Case 1, the reaction continues in alternate years around the same pathway, P_5, Q_7; P_7, Q_9; etc. Likewise, the price and supply of the second year, Q_2 and P_2, are followed two years later by reduced supply, Q_4, and increased price, P_4; four years later by Q_6, and P_6, and so on *ad infinitum*.

CASE 3B: THREE-YEAR LAG IN SUPPLY, CONVERGENT FLUCTUATION

A further illustration of delayed response may be developed by assuming a production period three years in length. This also may

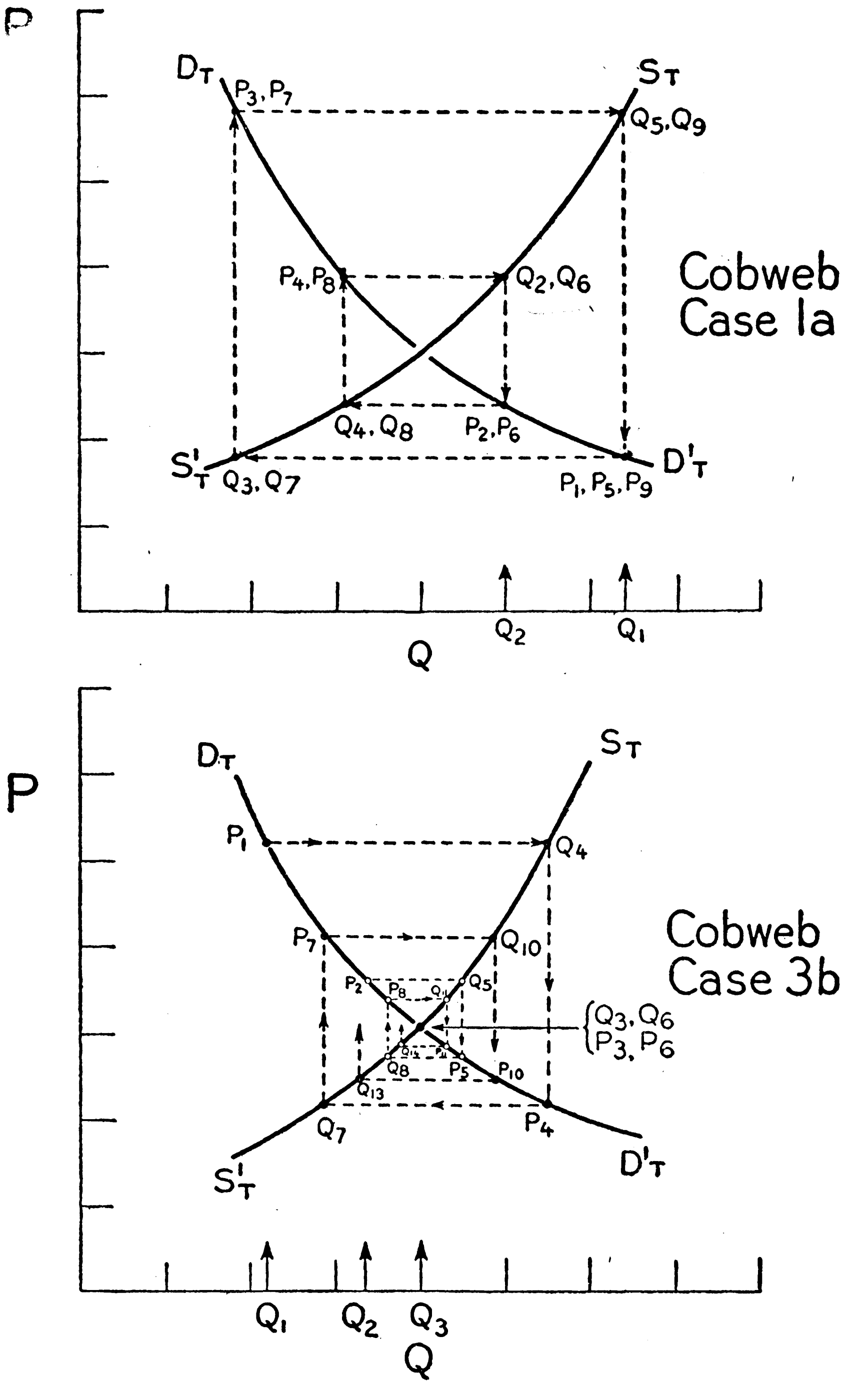


FIG. 12.—The mechanics of continuous and convergent cycles in prices and production, with a two-period lag in production response. (From Ezekiel, *see* footnote 1, page 30.)

be combined with any of the three original cases. Applying it to the third case, results are secured as shown in the lower portion of Figure 12, which may be regarded as Case 3b.

Here three initial supplies are assumed: Q_1, very small; Q_2, moderately small; and Q_3, just equal to the normal supply. The corresponding prices, P_1, P_2 and P_3, produce reactions in production three years later as shown: Q_4, a great expansion; Q_5, a moderate expansion; and Q_6, no expansion. The resulting prices, P_4, P_5, and P_6, produce corresponding effects on production three years further on, at Q_7, Q_8, and Q_9; and so on. Since the case is of the convergent type, the "cobwebs" traced by the 1-, 4-, 7-, 10-series and the 2-, 5-, 8-, 11-series converge slowly, while the 3-, 6-, 9-series, starting at equilibrium, remains there.

Various other combinations could be developed by assuming even longer periods of response, or by making other combinations with the three basic cases.

THE TIME SERIES TRACED BY PRICE AND PRODUCTION

Figure 13, which is a time series chart of prices and production in the successive periods shown in Figures 10 to 12, reveals more clearly the cyclical character of the resulting processes. Cases 1, 2, and 3, with a one-year lag in response, all produce two-year cycles. The continuous, divergent, and convergent character of the three cases is clearly evident, both in production and in price. Case 1a, with a two-year lag in production, has a four-year period from peak to peak; and Case 3c, with a three-year lag, a six-year period. The continuous character of the cycle in Case 1a, and the slow convergence of the cycle in Case 3c, are also apparent.

ILLUSTRATIONS OF CYCLIC BEHAVIOR

It is interesting to compare this synthetic time series with the actual price and production cycles for some specific commodities.

HOGS

Case 1a is similar to the actual four-year price and production cycles for hogs shown in Figure 9. The length of the lag in production response is shown clearly in Figure 14. The regularity of the simple cycles that would result if production were determined entirely by price is affected, in actual life, by the irregular fluctuations in the size of the corn crop, which are due chiefly to irregular

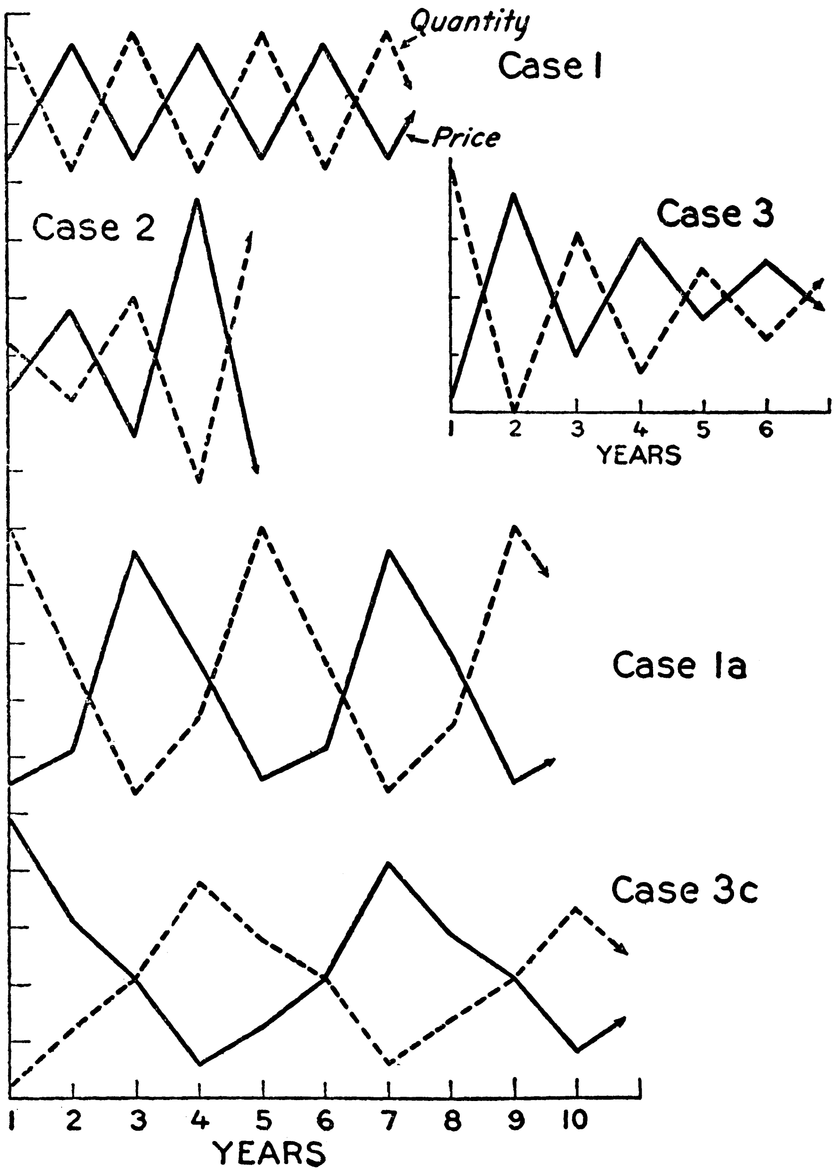


FIG. 13.—Time series of prices and production resulting from the cases shown in Figures 10 to 12. (From Ezekiel, *see* footnote 1, page 30.)

fluctuations in the weather. These irregular natural variations affect the regularity of the cycles that would result if production were determined entirely by price.

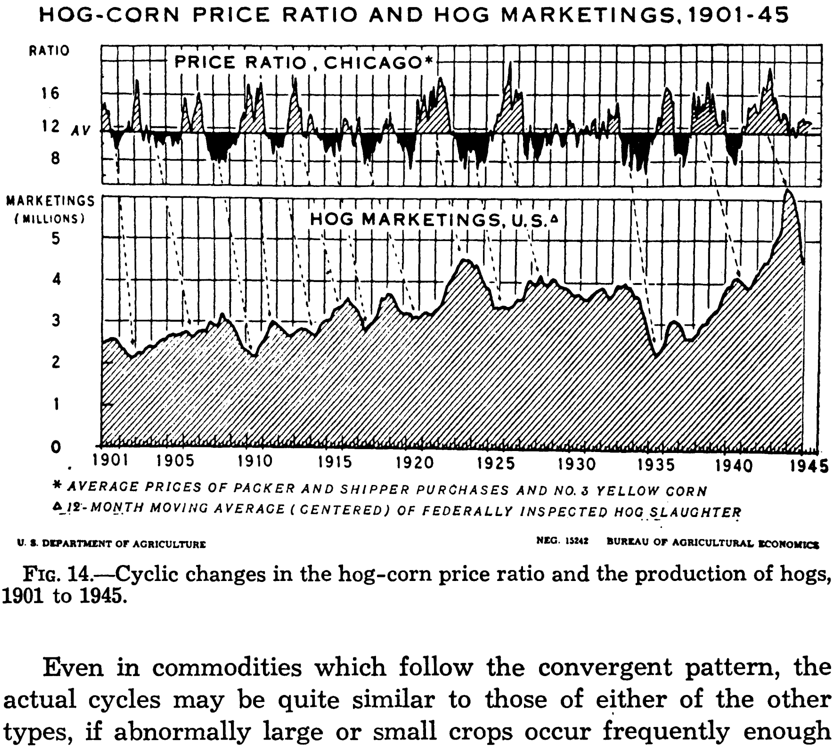


FIG. 14.—Cyclic changes in the hog-corn price ratio and the production of hogs, 1901 to 1945.

Even in commodities which follow the convergent pattern, the actual cycles may be quite similar to those of either of the other types, if abnormally large or small crops occur frequently enough to cause a marked departure from normal and to start again a long series of convergent cycles before stability is again approached. The combination of "cobweb" reactions with occasional crop disasters or gluts may be sufficient to produce recurring cyclical changes in production and prices, rather than stability, as the normal situation.

ALTERNATE MAJOR AND MINOR CYCLES

The alternation between major and minor hog price and production cycles shown in Figures 9 and 14 is interesting. It could mean that the hog price and production cycles converge, at least from extreme departures from normal. Perhaps something gives it a vigorous push and sets it in motion about every 8 years, starting a major cycle which converges or damps down to a minor one.

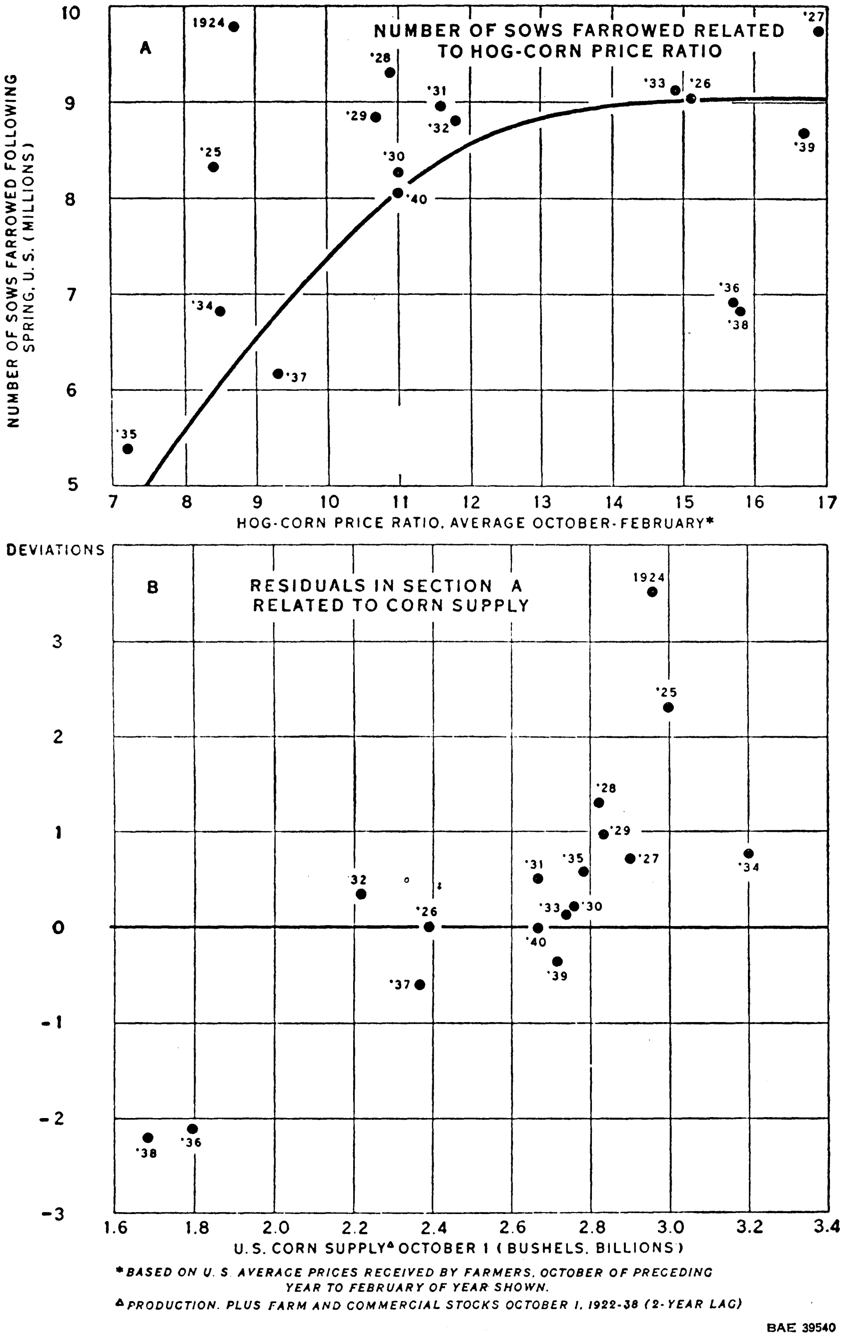


Fig. 15.—Relations between the United States hog-corn ratio, corn production, and sows farrowed: (A) average hog-corn price ratio October–February against United States sows farrowed the next spring; (B) residuals from (A) against corn production the year before. (The effect of corn production in the current year is already reflected in the hog-corn price ratio.)

This may be true. It is clear from Figures 10 and 11 that when the slopes of the supply and demand curves are equal, the cycle is self-perpetuating; it runs on without expanding or contracting. It is also clear that when the supply curve slopes upward more steeply than the demand curve, the cycle converges; and conversely. Let us examine the actual slopes of the actual market demand and supply curves for hogs, and see whether they would cause self-convergent, or continuous, cycles.

Figure 43 in Chapter 9 of this book, together with other evidence, shows that the actual market demand curve for hogs is a straight line on arithmetic paper, with an average elasticity of about —0.65. The elasticity of supply, in terms of hog-corn price ratios rather than hog prices, and in terms of the number of sows farrowing in the spring, is shown by Figure 15 to be about 1.0 for moderate departures

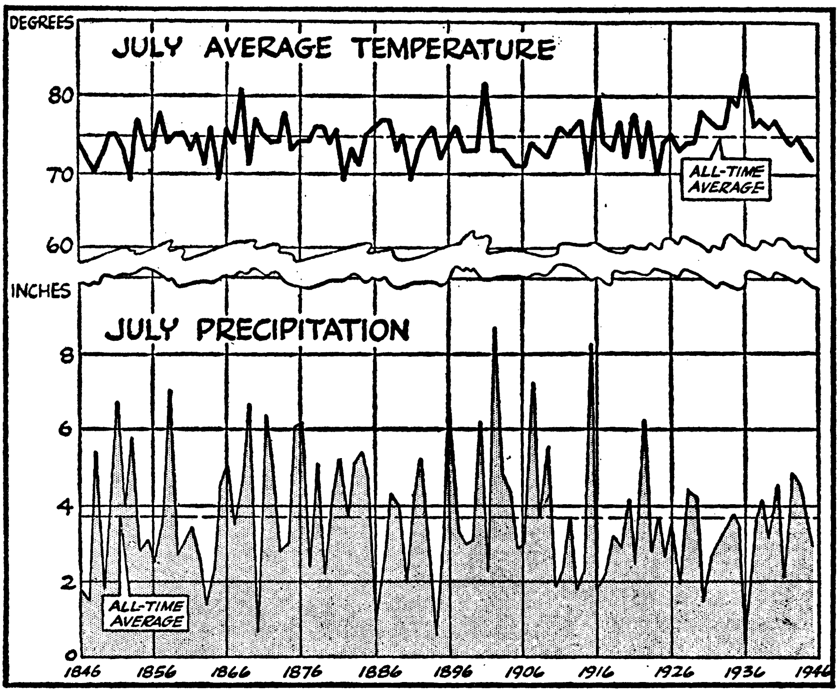


FIG. 16.—July average temperature and precipitation in Iowa, 1846 to 1946. The temperature is relatively stable, but the rainfall fluctuates markedly. There appears to be no trends or cycles in either series. (*Source, The Des Moines Register*, July 14, 1946.)

from equilibrium.[2] But the elasticity declines almost to zero for extreme departure above the equilibrium point.

If these curves were plotted on the same kind of charts as Figures 10 and 11, the demand curve for hogs would be a straight line with

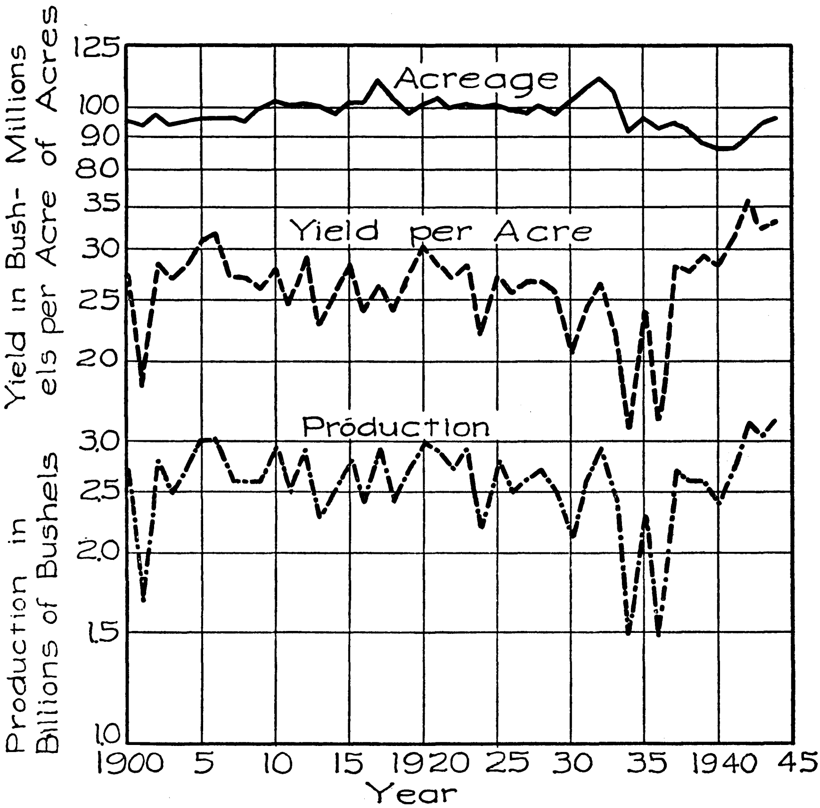


FIG. 17.—Corn acreage, yield per acre, and production, United States 1900–1945.

a slope of about 60 degrees (downward and to the right). The supply curve for hogs would have a slope of 45 degrees upward and to the right at the equilibrium point, but about 20 per cent above that point would curve upward until it gradually approached a vertical line going straight up. This means that the hog cycle, set in motion by some outside force such as a war (affecting the demand) or a

[2] For another chart bearing on this subject, and a more detailed discussion, see *Controlling Corn and Hog Supplies and Prices,* Tech. Bul. No. 826, USDA, 1942, by the present author.

drouth (affecting the supply) would converge down to about 20 per cent above equilibrium but self-perpetuating at that point and indeed expanding (divergent) below that point.

CYCLES IN WEATHER?

It is more difficult to discover any periodic disturbances, recurring about eight years apart, that would set the hog cycle in motion.

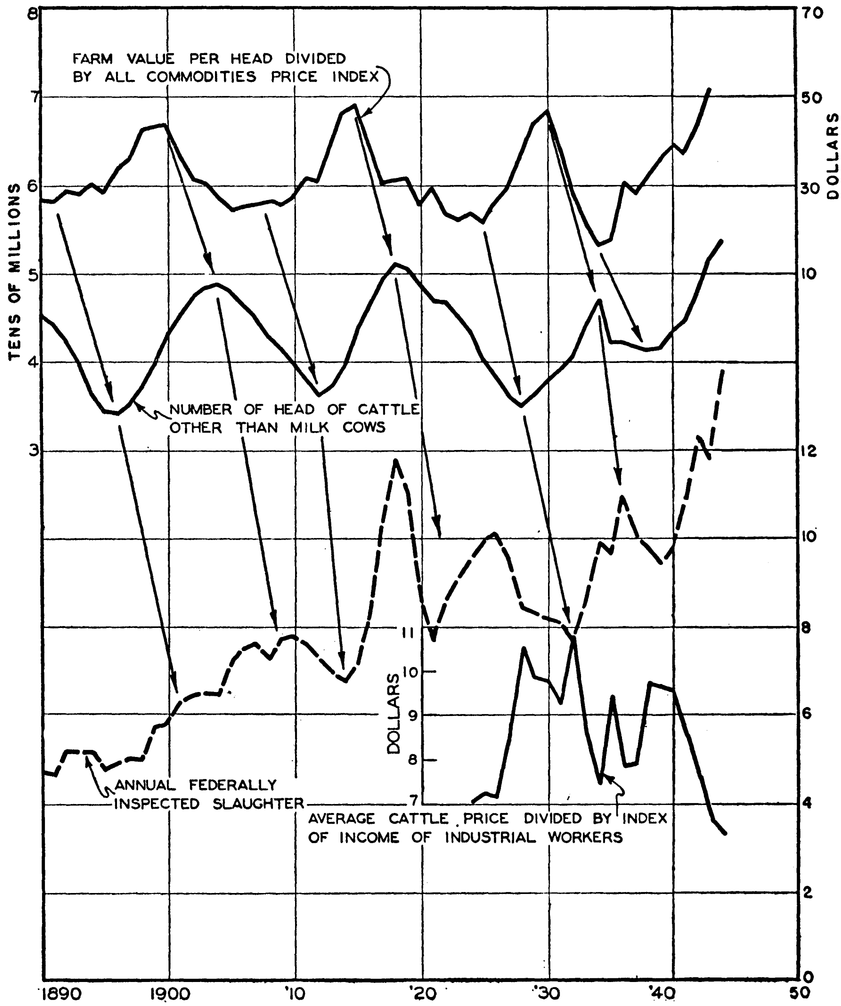


FIG. 18.—Beef cattle cycles. Farm value per head, number of cattle other than milk cows, federally inspected slaughter of cattle, and average price of cattle slaughtered, 1890 to 1946.

Various investigators in the past have thought that by the use of mathematical methods they had discovered cycles in the weather—three-year cycles, eight-year cycles, eleven-year cycles, etc. These periods are so varied, and the cycles are so poorly defined, that there is real question whether there really are any cycles at all. Certainly, direct visual inspection of one hundred years of weather data in the heart of the Corn Belt, such as those shown in Figure 16, reveals no marked periodic eight-year cycles sufficient to give the hog cycles a recurring big push. Neither do the corn yield and production data shown in Figure 17.

BEEF CATTLE CYCLES

The price and production of beef cattle also move in cycles. These cycles are clearly shown in the upper part of Figure 18. The data are given in Table 2. The farm value per head of cattle other than milk cows, divided each year by corresponding Bureau of Labor Statistics index of all commodity prices at wholesale, shows four prominent peaks about fifteen years apart from 1890 to 1944.

Some investigators believe that these movements in the production and prices of beef cattle are not really cyclic or periodic. A study of the five outstanding cyclic movements during the period 1866–1924 led Hopkins to conclude: "Each of these five movements was caused by a set of forces or conditions which were unusual, at least none of them recurred and caused another cyclical movement of like sort. Thus, it is not possible to predict any future cyclical movements on the basis of a further rapid extension of the range area like that which occurred from 1876 to 1884, nor is it possible to foresee that in any particular period there will be further economies introduced into the methods of producing beef such as those introduced from 1895 to 1905 or 1907.

"This study has uncovered no evidence that would lead one to expect a continuation of large upward and downward swings of cattle prices at any particular periodicity. On the other hand, as will be shown later, most of the fluctuations are closely related to natural and economic phonomena directly or indirectly connected with the production and consumption of beef, and which usually cast their shadows before them for a short period at least."[3]

Several other investigators, however, differ with Hopkins. They

[3] John A. Hopkins, Jr., *A Statistical Study of the Prices and Production of Beef Cattle,* Iowa Agr. Exp. Sta. Res. Bul. No. 101, December, 1926.

TABLE 2

CATTLE NUMBERS, VALUE PER HEAD, SLAUGHTER, AND PRICE PER 100 POUNDS*

Year	(1) Farm Value per Head Divided by the B.L.S. Wholesale Price Index	(2) Number Head of Cattle Other Than Milk Cows (000)	(3) Federally Inspected Slaughter (000)	(4) Annual Average Cattle Price Divided by the Income of Industrial Workers
1890....	27.00	45,014	4,748	....
1891....	26.40	44,835	4,687	....
1892....	29.00	42,949	5,206	....
1893....	28.40	39,955	5,190	....
1894....	30.80	36,476	5,190	....
1895....	28.90	34,280	4,809	....
1896....	33.90	33,939	4,939	....
1897....	35.80	35,065	5,053	....
1898....	43.10	37,227	5,045	....
1899....	43.20	39,833	5,748	....
1900....	44.00	43,195	5,801	....
1901....	36.30	45,868	6,312	....
1902....	31.80	47,426	6,465	....
1903....	31.10	48,787	6,755	....
1904....	27.40	48,957	6,702	....
1905....	25.20	48,288	7,259	....
1906....	25.70	46,779	7,541	....
1907....	25.90	45,125	7,633	....
1908....	26.60	42,997	7,279	....
1909....	25.60	41,573	7,714	....
1910....	27.30	39,543	7,808	....
1911....	31.80	37,803	7,619	....
1912....	30.90	36,158	7,253	....
1913....	38.30	37,012	6,978	....
1914....	46.30	39,640	6,757	....
1915....	48.70	43,579	7,153	....
1916....	39.80	46,686	8,310	....
1917....	31.00	49,767	10,350	....
1918....	31.50	51,504	11,829	....
1919....	32.10	50,549	10,091	....
1920....	25.90	48,945	8,609	....
1921....	29.80	47,258	7,608	....
1922....	22.60	46,944	8,678	....
1923....	23.20	45,408	9,163	....
1924....	23.50	43,665	9,593	7.05
1925....	21.80	40,798	9,953	7.23
1926....	26.30	38,166	10,180	7.15
1927....	29.50	35,927	9,520	8.60
1928....	37.50	35,091	8,467	10.50
1929....	44.90	36,437	8,324	9.87
1930....	46.70	37,971	8,170	9.70

TABLE 2—*Continued*

Year	(1) Farm Value per Head Divided by the B.L.S. Wholesale Price Index	(2) Number Head of Cattle Other Than Milk Cows (000)	(3) Federally Inspected Slaughter (000)	(4) Annual Average Cattle Price Divided by the Income of Industrial Workers
1931....	38.40	39,210	8,108	9.26
1932....	28.40	40,905	7,625	10.62
1933....	21.60	44,344	8,655	8.54
1934....	16.70	47,438	9,943	7.42
1935....	17.70	42,764	9,666	9.42
1936....	30.90	42,651	10,972	7.82
1937....	28.20	41,449	10,070	7.91
1938....	32.80	40,783	9,776	9.75
1939....	36.40	41,429	9,446	9.64
1940....	39.39	43,271	9,756	6.68
1941....	38.35	45,983	10,946	5.41
1942....	43.35	48,764	12,347	4.56
1943....	52.17	52,008	11,727	3.84
1944....	49.83	54,585	13,960	3.39

* Sources of data: (1) *Agricultural Statistics*, USDA, 1939, p. 308. Farm value per head of all cattle other than milk cows divided by the Bureau of Labor All Commodities Index of wholesale prices (1926 = 100). (2) Number of head of cattle other than milk cows. *Agricultural Statistics*, USDA, 1939, p. 308. (3) *Livestock, Meats and Wool Statistics and Related Data, 1939*, p. 21. (4) Average United States price of cattle (calendar year) divided by the index of income of industrial workers (1924–29 = 100). Cattle prices from *Livestock, Meats and Wool Market Statistics and Related Data, 1939*, p. 91. Income index from "Demand, Credit and Prices," *1941 Agricultural Outlook Charts*, p. 4. Recent data from recent editions of same sources.

believe that the movements in the production and prices of beef cattle are cyclic, self-perpetuating in character. The behavior of the production and price series since Hopkins wrote seems to support the cyclic hypothesis rather than his episodic theory. Well-marked peaks have continued to occur about fifteen years apart. They show up most clearly in the value series plotted in the upper part of Figure 18.

These cyclic movements in the value of beef cattle per head at the farm cause corresponding changes in the numbers of head of beef cattle on farms—not immediately, but after a lag of several years. This is shown by the second line from the top in Figure 18 which represents the number of head of beef cattle on farms January 1 each year. The downward sloping arrows between that line and the line at the top of Figure 18 show how high beef cattle values at the farm lead to increases in beef cattle numbers, and how low beef cattle prices lead to liquidation of beef herds. There is a four- or five-year lag between the two series; it takes several years to build up a herd, and even liquidation is usually a slow process. (The sudden liquidation in 1934 was an exception, due not to low prices but to severe drouth.)

The relations from then on are more complex. Large numbers of cattle on farms January 1 do not lead directly to high cattle slaughter the same year, as in the case of hogs. Hogs are ready for market less than a year after they are farrowed, but steers used to be carried to three, four, and five years of age before being sent to market. Even now, finished steers average about two years old at the time of slaughter. So there is a lag of about two years between numbers on farms and number slaughtered. When prices are high and numbers of cattle on farms are increasing, slaughter may be *decreasing,* since a larger than normal proportion of heifers may be kept on farms for building up breeding herds. This happened for several years after 1912, 1928, and 1938. On the other hand, if prices are low and numbers of cattle on farms are decreasing, liquidation of breeding stock may cause the market supplies to increase. This happened for several years after 1908, 1921, and 1934.

These things are well shown in Figure 18, where the annual federally-inspected slaughter of beef is shown by the next to lowest line in the chart. This line follows a cyclic pattern lagging from two to four years after the cycles in numbers of beef cattle on farms shown by the line above it, with only one conspicuous interruption. The wartime demand for beef during World War I moved the peak of slaughter that normally would have come in 1920–22 forward to 1918, and the spot from which the peak was moved became a trough.

The final link in the chain of causation is the concurrent inverse correlation between the slaughter and the price of beef cattle. This is revealed by a comparison of the cyclic movements in the slaughter line in the lower part of the chart with the farm-value-per-head line at the top. This relation is not very close, for (1) prices at the farm are affected by the demand for breeding purposes as well as by the amount of slaughter, and (2) the effects of changes in demand upon beef cattle prices are only partly removed by dividing the value-per-head series through by the index of the general price level. The inverse relation between slaughter and prices is shown more accurately if the prices used are the prices of the beef cattle slaughtered (what is called the cost to packers) with the effects of changes in demand removed by division of the prices each year by the corresponding index of the income of industrial workers. (This index is available only as far back as 1924, and the cost to packers goes back only to 1921.) This "deflated" beef cattle price is shown by the lowest line in Figure 18.

POTATOES

Another application of the cobweb analysis to actual commodity data is provided by the data for potato prices and production, given in Table 3. The farm price for the crop season is adjusted for changes in price level by dividing by the index of wholesale price level. The relation of these deflated prices, both to production of the current year and to production of the subsequent year, is shown in Figure 19.

This figure shows two points for each year, one point shown as a dot and the other shown as a hollow square. The dot labeled "37,"

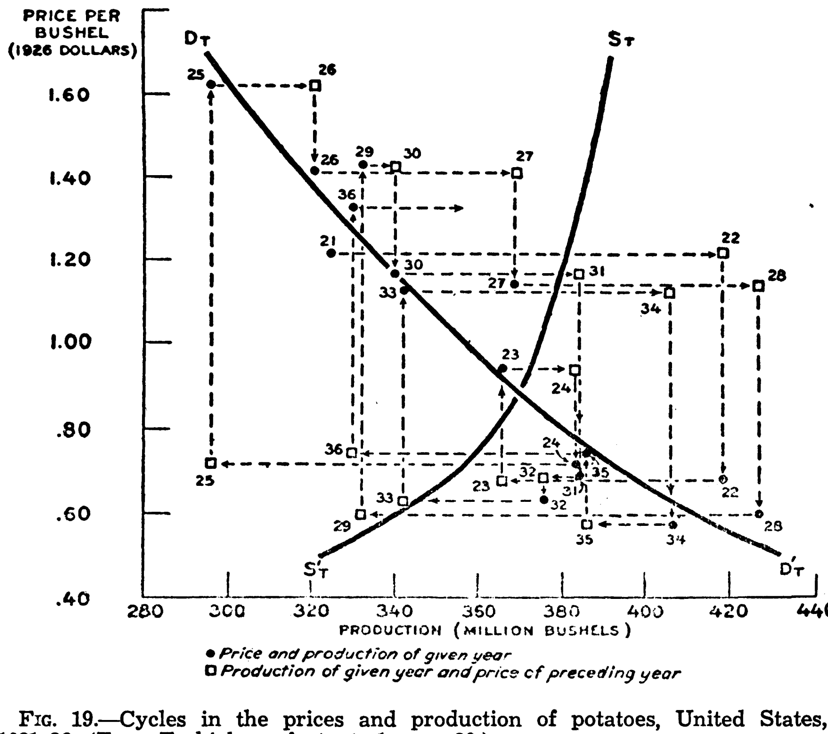


FIG. 19.—Cycles in the prices and production of potatoes, United States, 1921–36. (From Ezekiel, *see* footnote 1, page 30.)

TABLE 3

POTATO ACREAGE, YIELD, PRODUCTION, AND SEASON AVERAGE PRICE: UNITED STATES, 1921–45

Crop Year*	Acres Planted (000)	Yield Per Acre (bushels)	Production (million bushels)	Average Farm Price (cents per bushel)	Wholesale Price Level (1926 = 100)	Deflated Farm Price (cents per bushel)
Data for Figure 19						
1921	3,598	90.4	325.3	113.5	93.7	121.1
1922	3,946	106.3	419.3	68.6	101.2	67.8
1923	3,378	108.5	366.4	91.5	98.1	93.3
1924	3,106	123.7	384.2	71.2	100.5	70.8
1925	2,810	105.5	296.5	165.8	102.5	161.8
1926	2,811	114.4	321.6	136.3	97.0	140.5
1927	3,182	116.2	369.6	108.5	96.1	112.9
1928	3,499	122.1	427.2	57.1	96.2	59.4
1929	3,019	110.0	332.2	131.8	92.5	142.5
1930	3,103	109.8	340.6	91.8	79.0	116.2
1931	3,467	110.8	384.1	46.3	68.2	67.9
1932	3,549	106.1	376.4	39.2	62.9	62.3
1933	3,412	100.3	342.3	82.1	72.0	114.0
1934	3,597	112.9	406.1	44.8	78.0	57.4
1935	3,551	109.1	386.4	59.7	80.1	74.5
1936	3,058	107.9	330.0	111.3	84.0†	132.5
Data for Figure 20						
1937	3,119	123.2	376.4	52.9	86.3	61.2
1938	2,944	124.0	355.8	55.7	78.6	70.9
1939	2,867	121.7	342.4	69.7	77.1	90.4
1940	2,900	132.1	375.8	54.1	78.6	68.8
1941	2,768	131.2	355.6	80.7	87.3	92.4
1942	2,789	136.9	370.5	117.0	98.8	118.4
1943	3,441	139.6	464.9	131.0	103.1	127.1
1944	2,922	131.1	383.1	149.0	104.0	143.3
1945	2,824	150.6	425.1	141.0	106.0	133.0

* July to June, inclusive.
† On basis of first ten months.
Source: Bureau of Agricultural Economics.

for example, has for co-ordinates the 1937 price and the 1937 production; the hollow square labeled "38" has for co-ordinates the 1937 price and the 1938 production. The dots should indicate the demand curve, the squares the supply curve (insofar as it can be shown by such a simple analysis). The supply and demand curves have been drawn roughly, according to these indications.[4] The successive readjustments between production, price, and production are indicated by the dotted lines.

This figure presents the potato data according to a one-year response analysis. Actually, potato acreage is influenced by prices of both one year and two years previous, so that an average of the two preceding prices would give a better explanation of acreage changes than the preceding price alone. Furthermore, increase in acreage of potatoes in any one year is limited; Bean has shown that a 10 per cent increase is the limit of response, regardless of price.[5] This successive accumulation of increases is shown clearly in Figure 19. Following the high price of 1925, production increased each year until 1928; following the high price of 1929, production increased in 1930 and 1931. The very large increase in production in the single year 1922 was due more to a great difference in yield than in acreage. On the downside, however, single-year changes predominate, as from 1924 to 1925, 1922 to 1923, and 1928 to 1929. The line S_tS_t' is therefore not the true supply curve, in the sense that a price of $1.60 will call forth a production of 390 million bushels the next year.

[4] In drawing the curves, production has been regarded as the independent factor determining the dependent factor, price, and price as the independent factor determining the dependent factor, subsequent production. Accordingly, the curves have been roughly drawn so as to minimize the price (or vertical) departures of the dots from the demand curve, and the production (or horizontal) departures of the squares from the supply curve. This is not the most accurate way to determine either demand or supply curves; for the former, price level, consumer buying power, and other related factors may need to be considered as separate variables; for the latter, changes in acreage should be studied, prices one, two and more years preceding, and prices of cost factors or alternative commodities, may all need to be considered. The present illustration is not an example of price analysis, but merely an oversimplified illustration.

The carryover of potatoes has been neglected in computing the total supply, since potatoes are so perishable that the carryover from the previous year's crop has no perceptible effect on prices, except upon new-crop potatoes from southern points early in the season.

The elasticity of the demand curve shown is —0.37. This is very close to the elasticity derived by more complicated multiple regression analyses reported later in this book. The elasticity of supply shown here is similarly confirmed by later studies.

[5] Louis H. Bean, "The Farmers' Response to Price," *Journal of Farm Economics* XI, No. 3, July, 1929, p. 380.

Rather, it shows that at prices above 90 cents, production the next year will usually increase, though within a limited range, while at prices below 90 cents, production the next year will usually decrease.

With these reservations in mind, we may examine Figure 19 for evidence of "cobwebbiness." There is an apparent tendency for

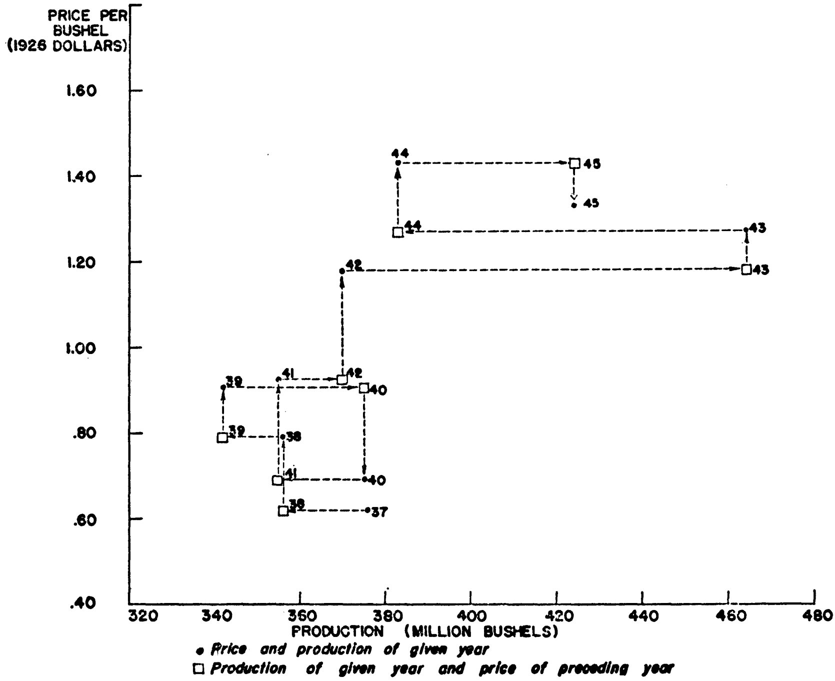


FIG. 20.—Cycles in the prices and production of potatoes, United States, 1937–45.

the reaction to swing around the point of overlap (long-time equilibrium). From 1921 to 1924 the cycle converged. In 1925 an exceptionally low yield per acre started a new cycle under way, which appeared to "damp down" until 1928, when an unusually high yield per acre threw it out of balance again. Again in 1932, production was near the equilibrium amount (though price was low because of depressed demand); a very low acre yield in 1933 started a new cycle under way. Potatoes thus illustrate the case of a commodity where the supply-demand relation tends to converge towards equilibrium, but where occasional years of high or low yields occur often enough to maintain practically continuous oscillation.

Figure 19 was originally prepared in 1937, and the last data that appear in it are those for 1936. If the data since 1936 were added to the chart they would crowd it so full of dots and lines that it would be difficult to read. The data since 1936, therefore, are shown separately in Figure 20.

This figure shows that the data from 1937 to 1941 exhibit the same kind of clockwise rotation about an equilibrium point that the earlier data show in Figure 19. The great demand for food after 1941 shifted the demand curve upward and to the right, taking the large crop of 1942 and the extremely large crop of 1943 at higher prices, not lower prices, than before. After 1943, however, the cyclic rotation began to re-establish itself about a new and higher point.

CYCLIC SEASONAL MOVEMENTS

The prices of most farm products exhibit a regular cyclic movement within the season—from a low price point during the weeks of heaviest market receipts to a high price peak later in the season when supplies are at their lowest. On the average, the rise from low to high is about equal to the extra cost of producing the commodity "off-season"; or, in the case of annual crops, the rise in price is equal to the cost of storage from harvest time until later in the year. But there is much variation from year to year.

This is a comparatively simple phenomenon, requiring only simple statistical techniques for its analysis. For this reason, and because it is discussed fully elsewhere,[6] it is not investigated here.

[6] Warren C. Waite and Rex W. Cox, *Seasonal Variations of Prices and Marketings of Minnesota Agricultural Products, 1921–1935,* Minnesota Agr. Exp. Sta. Tech. Bul. 127, March, 1938. *See also Marketing Farm Products,* Chapter 8, Iowa State College Press, 1946, by the present author.