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 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 3.1 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 3.2.[1] The demand curve is represented

[1] Figures 3.2 and 3.3 are a part of the "Cobweb Theorem" as originally prepared by Mordecai Ezekiel.

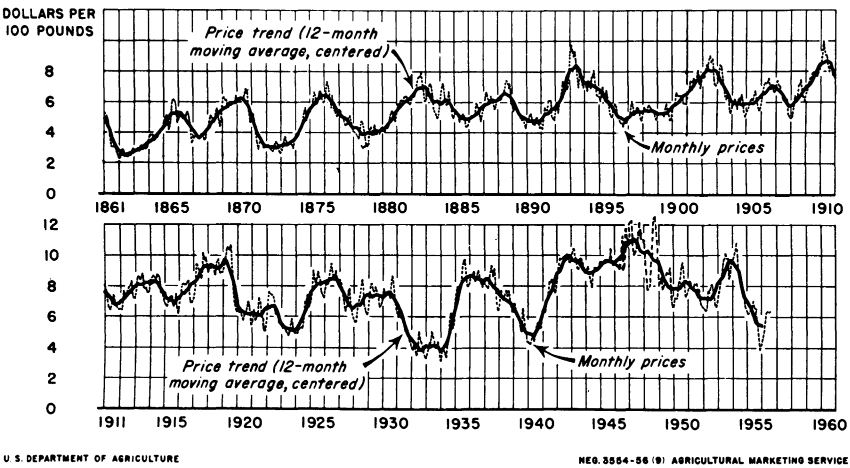

Fig. 3.1 — Cyclic changes in heavy hog prices at Chicago, 1861–1956, adjusted to 1910–14 price level.

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 3.2 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 3.2, 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 de-

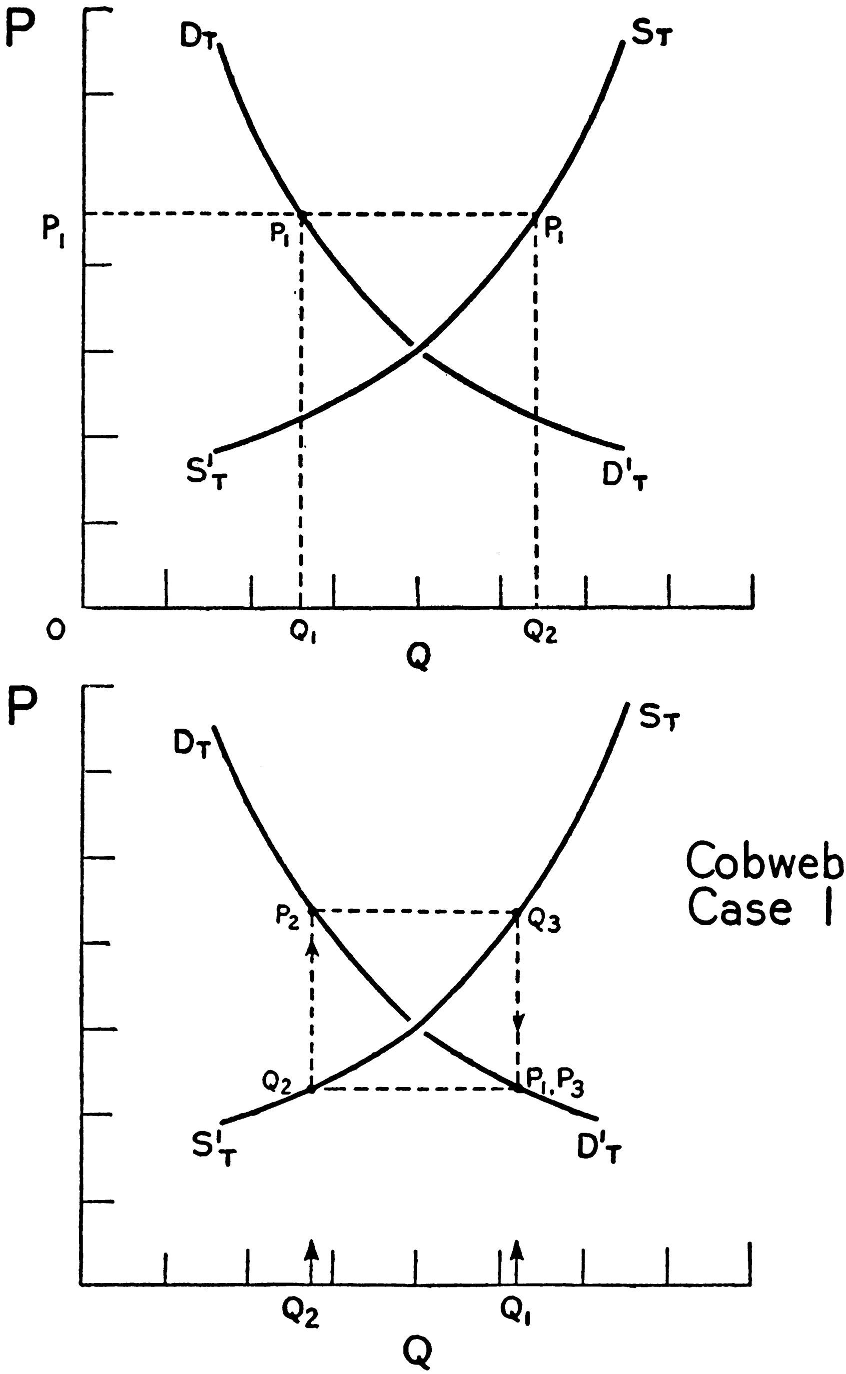

Fig. 3.2 — The mechanics of continuous cycles in prices and production.

mand 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 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 3.3. 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 3.3. 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

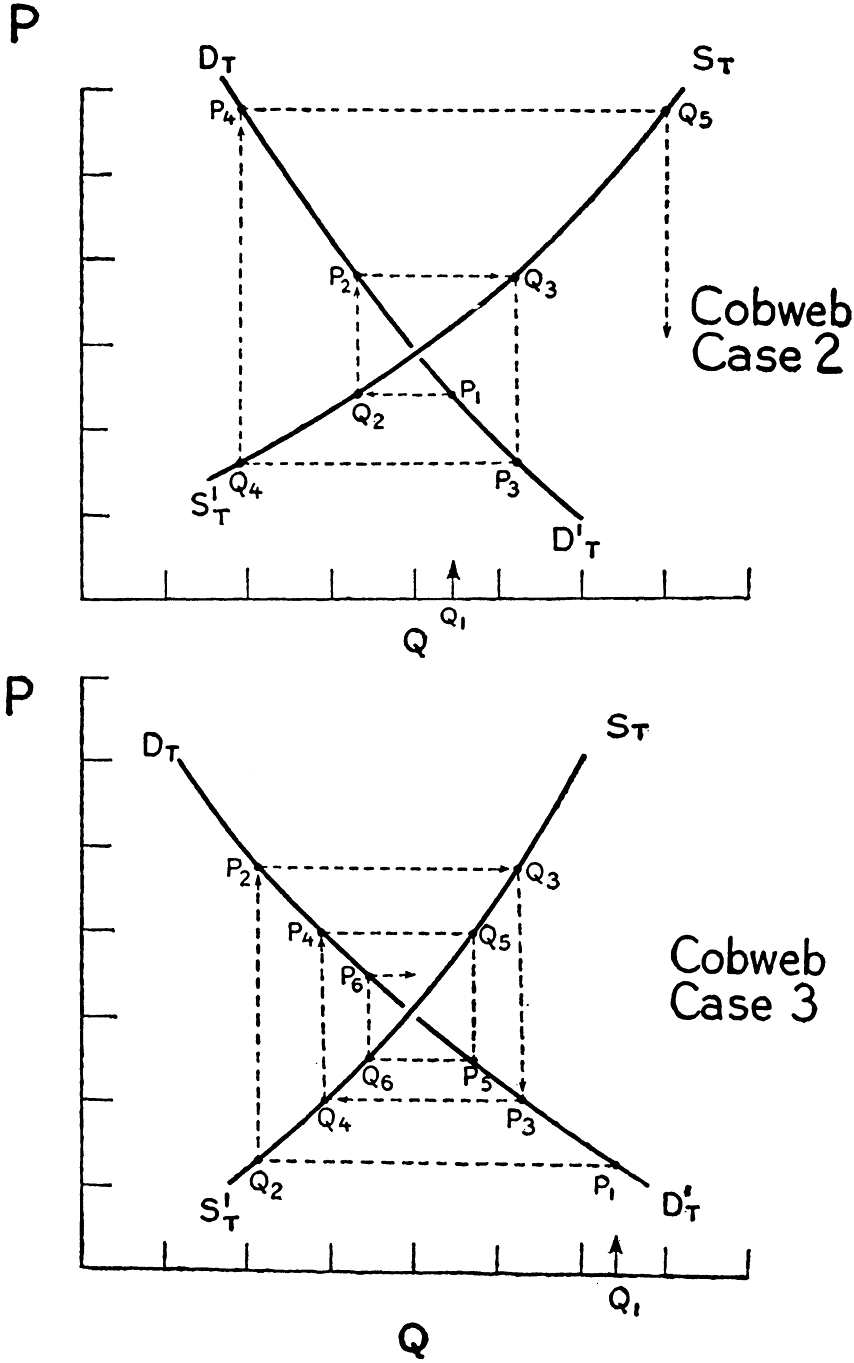

Fig. 3.3 — The mechanics of divergent and convergent cycles in prices and production.

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 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 beef cattle and various fruits) 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. The cycles in these cases will be several years in length.

The same general "cobweb" analysis applies here. The exposition is more complicated, but the principles are the same.

ILLUSTRATIONS OF CYCLIC BEHAVIOR

The principles can be illustrated by the actual price and production cycles for several commodities where the lag between the price and the response of production to that price is longer than one year.

Hogs

The four-year hog price cycles for the years 1861–1956 were shown a few pages back in Figure 3.1. 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 fluctuations in the weather. These irregular natural variations affect the regularity of the cycles that would result if production were determined entirely by price.

Even in commodities which follow the convergent pattern, the actual cycles may be quite similar to those of either of the other

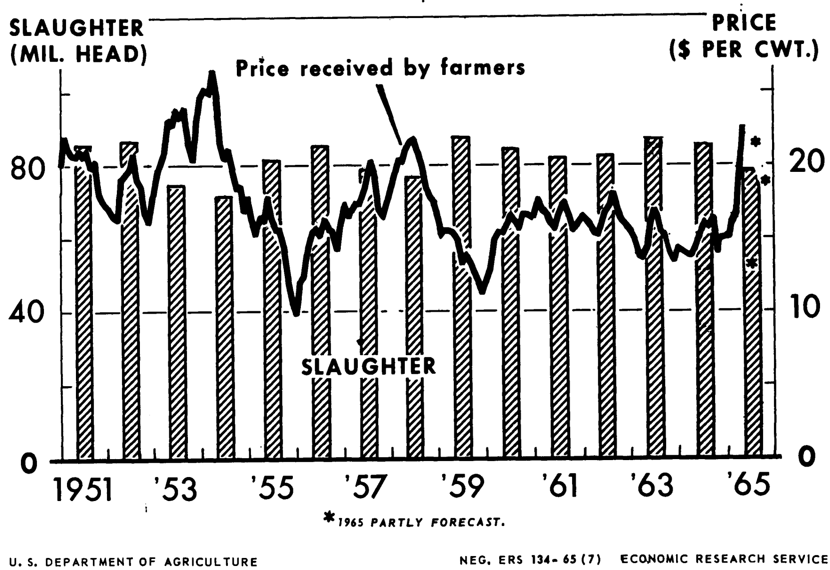

Fig. 3.4 — Cycles in hog slaughter and price, 1951–65.

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.

Evidence in recent years, however, indicates that the four-year hog production and price cycles are inherent in the internal conditions of the hog industry and do not require shocks from outside to keep them going. After 1952, the stabilization operations of the CCC were conducted on so large a scale that they almost completely damped down year-to-year variations in corn prices. Yet hog production and prices continued their four-year cyclic movement much the same as before. The production (slaughter) and price cycles are shown in Figure 3.4; the pig crop cycles are shown in a different form in Figure 3.5. Their relation to the hog-corn price ratio the previous fall is evident.

LENGTH OF THE HOG CYCLE

The length of a cycle depends on the time required for a change in price to affect production. The time to produce an average market hog, from breeding to slaughter at about 230 pounds, is about 12 months. If the physiology of the hog were all that were involved,

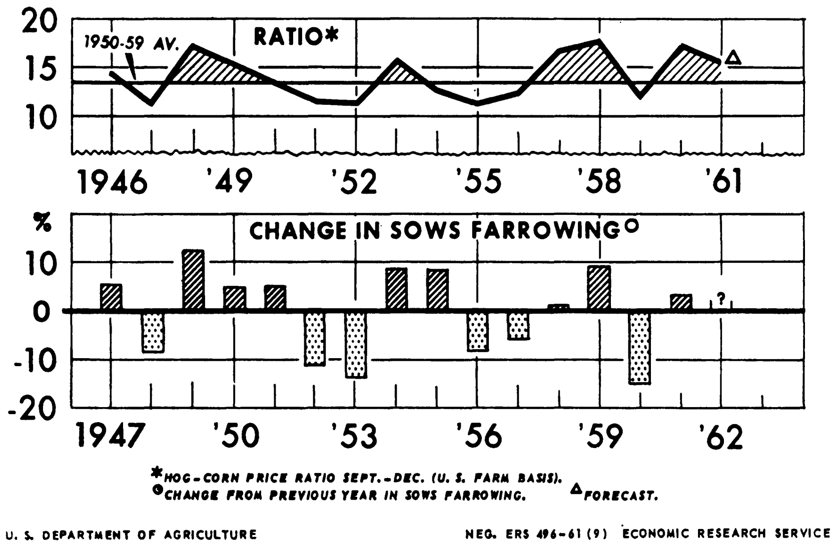

Fig. 3.5 — Cyclic changes in hog-corn ratio and spring farrowing, 1947–62.

the hog cycle would be two years in length. But actually it is about four years in length. Why is this?

The answer is that the psychology of the farmer is involved as well as the physiology of the hog. Farmers do not respond immediately to a change in price. The change in price might be only temporary; if it were temporary — say if it were a rise of $3 lasting only a month or two — farmers would be unlikely to breed many more sows, because even by the time the sows farrowed four months later, hog prices might have declined back to their previous levels. It is only after the price of hogs has remained high for a year or so that farmers pay enough attention to it to breed more sows, and six months more elapse before the pigs from this increase in the number of sows bred reach the market.

Apparently, farmers pay more attention to the length of time that a rise in prices persists than they do to the likelihood that when they do increase the number of sows they breed, other farmers will be doing likewise. The internal mechanism of the hog cycle is shown in Figure 3.6.[2]

Hog production and price cycles may decrease in the future. Farmers' reactions after 1950 were carried over from previous years,

[2] This figure and Figure 3.9 are taken from W. Maki, "Decomposition of the Beef and Pork Cycles," *Journal of Farm Economics,* XLIV, No. 3, August, 1962, pp. 731–43. For a still more intensive analysis, see A. A. Harlow, "Factors Affecting the Price and Supply of Hogs," USDA Tech. Bul. 1274, Dec. 1962.

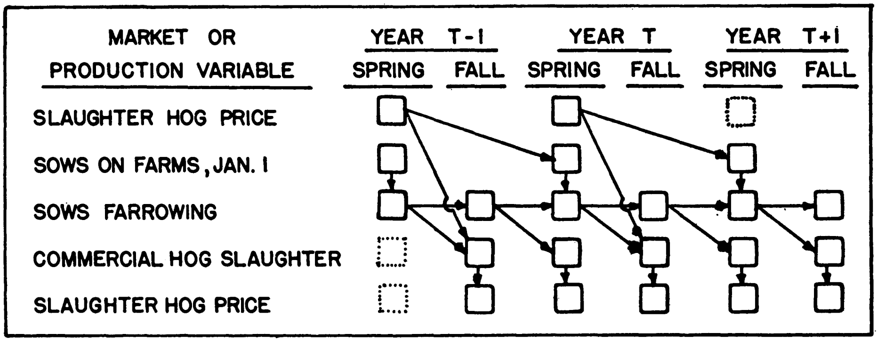

Fig. 3.6 — Internal mechanism of the hog cycle.

before corn prices became very stable. It may be that as farmers become adjusted to stable corn and other feed grain prices, and see the hog production and price cycle more clearly, that they will stabilize their hog production too. If not, it may be necessary to use more direct means to stabilize hog production, such as by making direct payments to farmers whenever hog prices fall cyclicly below a stable level.

Beef Cattle Cycles

The numbers of cattle on farms also move in cycles. These cycles are shown as a continuous series in Figure 3.7.

The cycles in beef cattle numbers are more than twice as long as the cycles in hogs, chiefly for physiological reasons. The gestation period for a cow is about 9 months, and a calf requires nearly two years to reach slaughter age.

The same data, carried back to 1896, are shown in a different form in Figure 3.8. In this figure, each cycle is plotted separately, beginning with the low point at the beginning of the cycle. This figure shows that the cycles have been getting shorter with the passage of time. It will be interesting to see whether this shortening of the cycle is only a temporary thing, or whether it continues in the future. It seems likely that it will continue, because beef cattle are being sold for slaughter now at a younger age than they were several decades ago—at one and one-half to two years of age, instead of two to three years. It will be interesting to see how the current cycle turns out.

The internal mechanism of the beef cycle is shown in Figure 3.9. The mechanism is a little more complicated than the mechanism of the hog cycle. The chain of events in the chart begins with feeder cattle prices. Changes in beef cow inventories January 1, listed

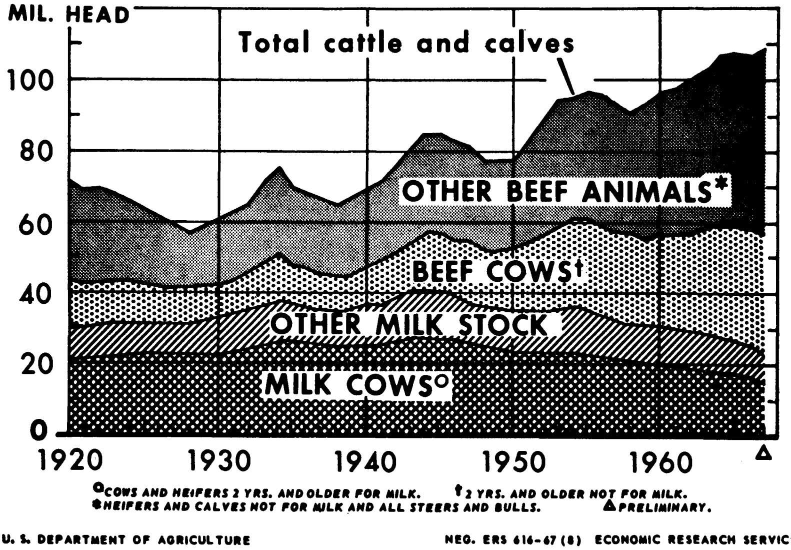

Fig. 3.7 — Comparison of all cattle on farms, January, 1920–67.

under "other cattle on farms" (this means other than dairy cattle) play a critical role. A small decrease in beef cow inventories, for example, would signal a much larger increase in commercial slaughter during the next year. Moreover, beef cows on farms would decline in numbers because of an increase in cow and heifer slaughter during the preceding year.

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.

The average seasonal variation, independent of other kinds of variation—irregular year-to-year, cyclic, secular, etc.—can be measured by any one of several different methods.

The simplest method is to assemble the monthly data over a fairly long period, such as the twenty years between World Wars I and II, and compute the average for each month separately. The averaging process eliminates most of the non-seasonal variation. A more complicated method is to use link relatives; this is a labo-

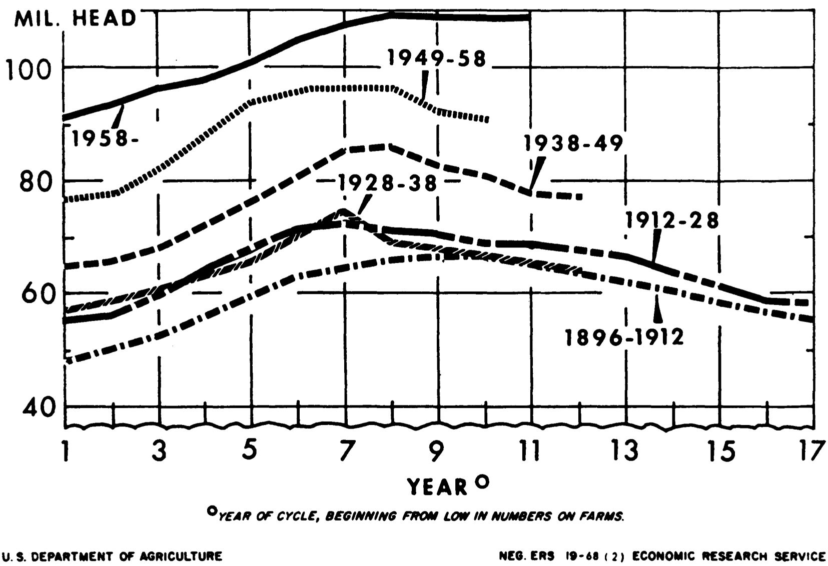

Fig. 3.8 — Number of cattle on farms by cycles, 1896–1968.

rious procedure, and the results usually are not much different from those obtained by the simple averaging process.

Still another method is to establish the trend of the series by computing a 13-month moving average of the monthly data, centered on the seventh month. The original value for each month is then expressed as a percentage of the moving average for that month. The average of these percentages is then computed for each month separately.

The variation or departure in individual years from the average seasonal variation can be measured by computing the average deviation of the percentage of trend for individual months about the value of the index of average seasonal variation for each month. This may be called the index of irregularity. A band of the size of this index on both sides of the index of average seasonal variation may then be plotted on a chart to show both the index of seasonal variation and the index of irregularity.

In a normal distribution, this band includes about 60 per cent of the individual items that make up the average. The narrower this band, the closer is the conformity of the individual years' seasonal movement to the average seasonal movement.[3]

[3] G. S. Shepherd, *Marketing Farm Products,* 5th ed., Iowa State Univ. Press, 1969, Chap. 11; also R. J. Foote and K. A. Fox, "Seasonal Variation: Methods of Measurement and Tests of Significance," BAE, USDA, 1952.

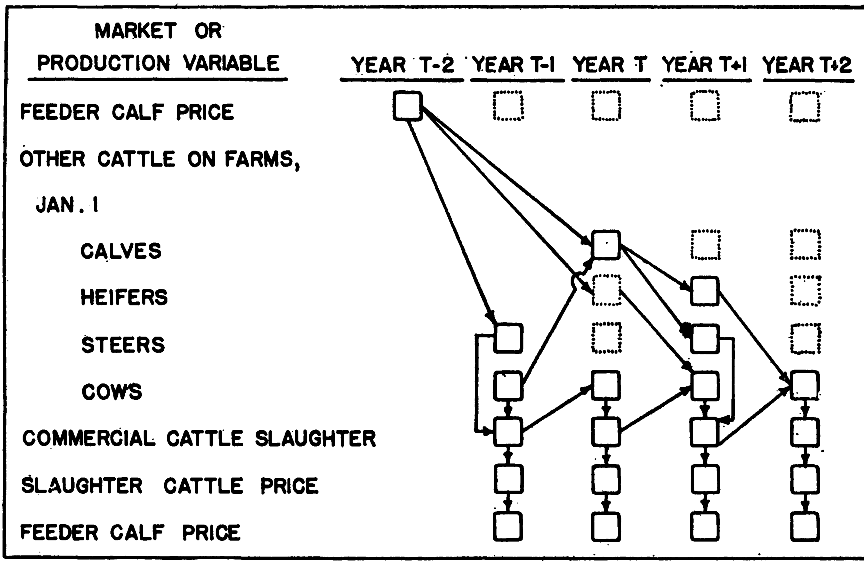

Fig. 3.9 — Internal mechanism of the beef cycle.

It is also possible to measure the closeness of the conformity of the whole seasonal movement in a particular year to the average seasonal pattern. This conformity may be computed for individual years by the formula

$$a = \frac{\Sigma\, d\, s}{\Sigma\, s^2}$$

where d is the percentage deviation of the individual month from the value of the moving average for that month and s is the deviation of the index of average seasonal variation from 100. In a year when the seasonal pattern corresponded exactly with the average seasonal pattern, this ratio would have a value of one.[4]

The amount of seasonal variation in the prices of several farm products has been decreasing chiefly because the amount of seasonal variation in the production of those products has been decreasing. An illustration of this is shown in Figure 3.10. Another way of showing changes in seasonal patterns with the passage of time is shown in Figure 3.11.[5] In cases like these, the average seasonal variation over the past five or ten years is not an accurate basis for estimating the seasonal variation over the next year or two.

[4] This measure was developed by S. Kuznets. See page 324, *Seasonal Variations of Industry and Trade*, Publ. 22, Nat. Bur. of Econ. Res.

[5] H. F. Gale, "Seasonal Variation in Farm Food Prices and Price Spreads," Misc. Publ. No. 840, USDA, 1961.

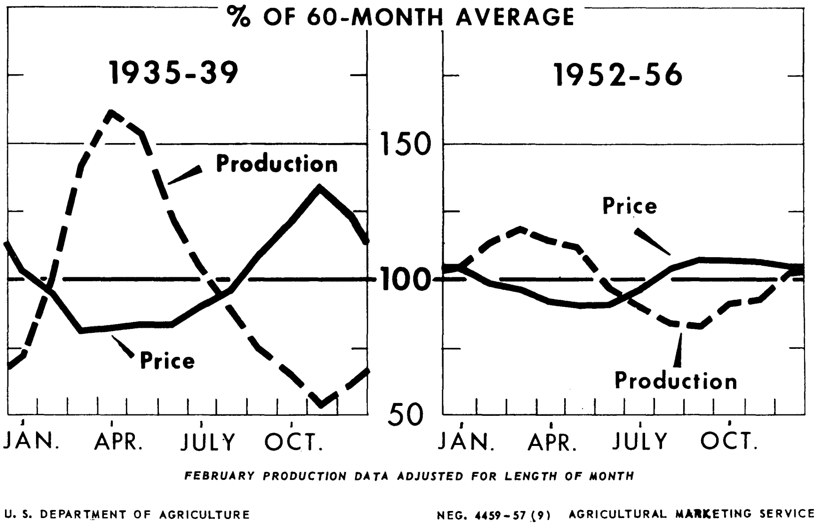

Fig. 3.10 — Average seasonal egg production and prices, 1935–39 and 1952–56.

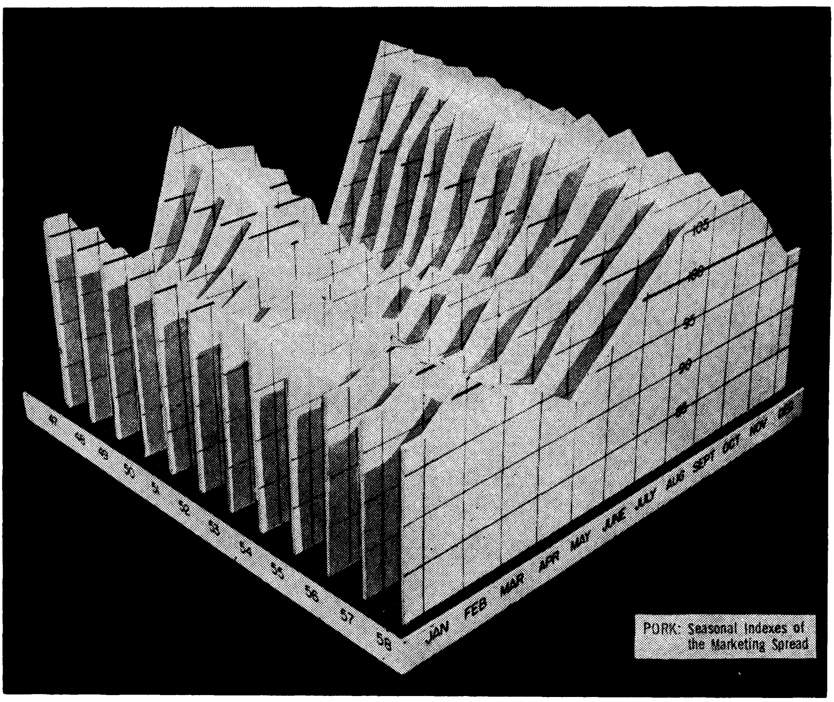

Fig. 3.11 — Monthly indexes of the farm-to-retail price spreads for pork, by years, 1947–58.

To take this into account, elaborate methods have been worked out for projecting trends in seasonal variation into the future. Briefly, the procedure involves plotting on a separate time chart for each month, the ratio between the price for that month, say January, and the 13-month moving average price centered on January. A trend line is then drawn through the ratios. If, for example, the ratios for January are represented by a trend line declining at the rate of 2 per cent per year, the January ratio for next year (in the future) would be 2 per cent lower than the trend value for the last year.[6]

This is not a very reliable procedure in itself, for it assumes uncritically that recent trends will continue in the future as in the past. Whether this is likely to happen is something that has to be established separately for each product on the basis of knowledge of that product.

Some problems involved in the graphic presentation of seasonal patterns, however, are discussed in Appendix B.

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[6] H. F. Breimyer, and C. A. Kause, "Charting the Seasonal Market for Meat Animals," USDA Handbook No. 83, 1955.

Breimyer gives a broad treatment of the demand for meat in "Demand and Prices for Meat," USDA Tech. Bul. No. 1253, 1961.

two

MEASURING THE ELASTICITY OF DEMAND AND SUPPLY