The Cobweb Theorem
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THE COBWEB THEOREM

SUMMARY

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History of the "Cobweb Theorem"

Regularly recurring cycles in the production and prices of particular commodities have been recognized by students of prices for more than fifty years.[1] Many economists have been disturbed by the apparent inconsistency between the persistence of these observed cycles and the tendency towards an equilibrium posited by economic theory. Descriptions of the mechanism of these self-perpetuating commodity cycles were well developed a decade or more ago, but despite various partial explanations, a definite theoretical explanation for them had not been established. Finally three economists, in Italy, Holland, and the United States, apparently independently, worked out the theoretical explanation which has since come to be known as the "cob-web theorem."[2] As it happened, all three papers were published in German, two in the same issue of the same publication. Only recently has the theory begun to be generally recognized in English-speaking countries.

1. S. Benner, Benner's Prophecies of Future Ups and Downs in Prices, Cincinnati, 1876.

For a bibliography of other early studies of the corn-hog price cycle, see "Factors Affecting the Price of Hogs," by G. C. Haas and Mordecai Ezekiel, U. S. Dept. Agr. Bul. 1440, 1926, pp. 67–68.

2. This name was apparently first suggested by Nicholas Kaldor in his article "A Classificatory Note on the Determinateness of Equilibrium," Rev. of Econ. Studies, Vol. 1, p. 122. | February 1934.

All three originators of the theory followed the same basic idea of carrying successive production, price, and production readjustments back and forth between the supply and demand curves. Schultz's demonstration[3] was the simplest, presenting merely one example, of the convergent type; but also plotting the resulting time-series of prices and quantities. Tinbergen's analysis was more complete, presenting both the convergent and divergent types,[4] and referring to Hanau's statistical analysis of hog prices in Germany[5] as a realistic illustration. Ricci's analysis, published in the same issue with Tinbergen's, presented diagrams of all three basic types, convergent, divergent, and continuous.[6] In each case, these first statements of the cobweb analysis were introduced only incidentally. Schultz used it as an illustration of the difference between simultaneous readjustment of supply to demand and lagging readjustment; Tinbergen as showing that where the production response lags behind the price change "instead of equilibrium being reached . . . a continuing movement of price and production is possible"; and Ricci as a basis for showing (in a review of Moore's work) how important were the precise values of the elasticities of supply and demand, since such greatly different economic consequences might follow from slight differences in their numerical values. No one of the three, however, considered the broader significance of the cobweb theory in its relation to economic theory as such.

Subsequently, in the article cited above, Kaldor called attention to the cobweb analysis as bearing on the determi-

3. Henry Schultz, Der Sinn der Statistischen Nachfragen, Heft 10, Veröffentlichungen der Frankfurter Gesellschaft für Konjunkturforschung, Kurt Schroeder Verlag, Bonn. 1930. See especially page 34.

4. J. Tinbergen, Bestimmung und Deutung von Angebotskurven, Ein Beispeil, Zeitschrift für National Ökonomie, Wien, Band 1, Heft 5, 1930, p. 671.

5. Arthur Hanau, Die Prognose der Schweinepreise, Sonderheft 7 and 18, Vierteljahrshefte zur Konjunkturforschung, Institut für Konjunkturforschung, Berlin, 1928 and 1930.

6. Umberto Ricci, Die "Synthetische Ökonomie" von Henry Ludwell Moore, Zeitschrift für Nationalökonomie, Wien, Band 1, Heft 5, 1930, p. 656.

nateness of equilibrium in those cases "where the adjustments are completely discontinuous"; and Leontief showed that where the supply or demand curves are of an erratic shape, the same set of curves might produce either a convergent or a divergent series.[7] The cobweb theory has also been discussed as a theoretical explanation for the hog cycle in England.[8] More recently, it has been incorporated in an American elementary text on economic theory.[9] Despite this increasing attention to it, however, the theory has remained substantially in the form first stated by its originators. This article attempts to develop the theory more generally, and to clarify its relation both to neo-classical economic theory and to statistical price analysis.

Restatement of the Theory of Market Price

The price on a current market, under conditions of pure competition,[1] over a given limited period of time tends to be determined by the interaction of the supply and demand on that market. Demand (indicated by the curve DD' in section A of Figure 1) represents the schedule of the number of units of the commodity (Q) which purchasers stand willing to buy within the period specified at varying prices (P); supply (indicated by the curve SS') represents the number of units of the commodity which holders (or producers) of the product stand willing to sell within the specified period at varying prices. Since for every purchase there must be a sale, the quantity sold must equal the quantity bought.

7. Wassily Leontief, Verzögerte Angebotsanpassung und Partielles Gleichgewicht, Zeitschrift für Nationalökonomie, 1934.

8. R. H. Coase and R. F. Fowler, Bacon Production and the Pig-Cycle in Great Britain, Economica, Vol. II, No. 6, pp. 143; also reply by Ruth Cohen and J. D. Barker, and rejoinder by Coase and Fowler, in Vol. II, No. 8, pp. 408–428. 1935.

9. Archibald MacDonald McIsaac and James G. Smith, Introduction to Economic Analysis, pp. 430–435. 1936.

1. Here "pure" is used in the same sense as that given by Chamberlin; the market may be imperfect, but if competition is pure, i.e., not monopolistic, the supply and demand curves define the condition of equilibrium. See Edward Chamberlin, The Theory of Monopolistic Competition, pp. 12–29. 1936.

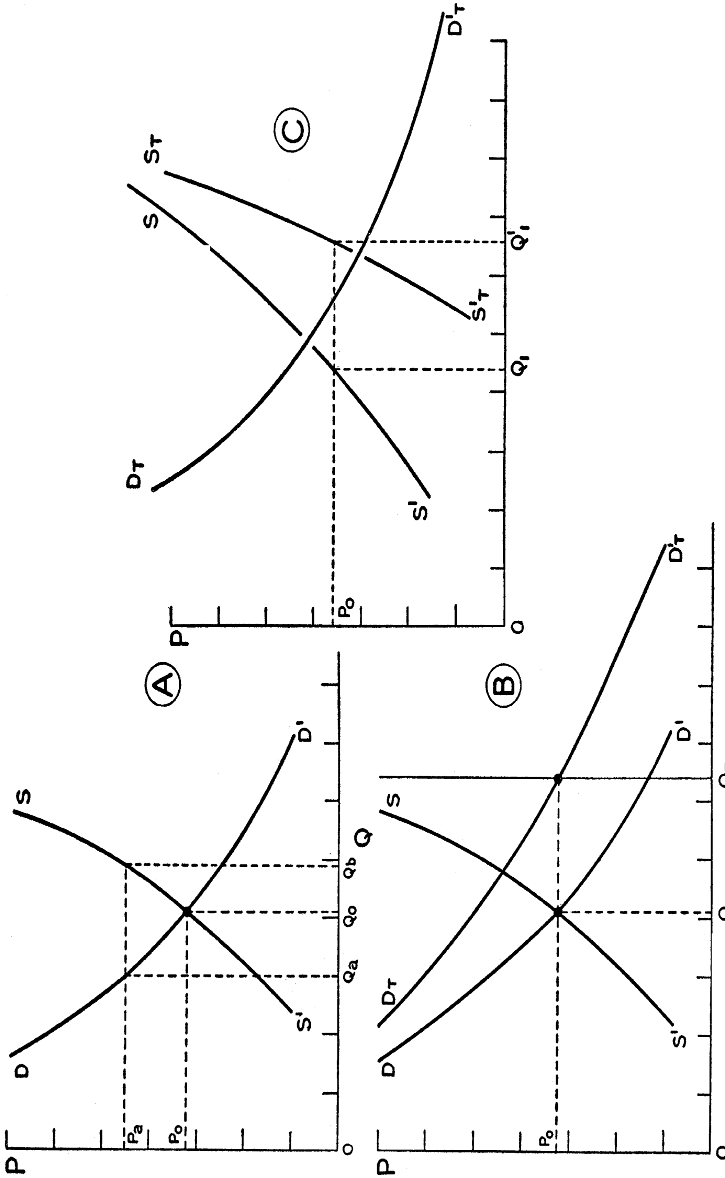


FIGURE 1

Under pure competition the equilibrium price for the market is indicated by the intersection of the two curves, with the coördinates P_o and Q_o.

For a commodity where the production process occupies a definite interval of time, the period considered may be taken as so short that the total supply available cannot be changed within the period (as, for example, the supply of cotton or potatoes once the year's crop is harvested). The situation under which the current market price is determined for such a commodity is shown in section B of Figure 1. Here the total supply (OQ_t) is represented by the vertical line with its abscissa at Q_t. The demand is represented as before by DD'. As has been shown earlier,[2] under such conditions the reservation demands of holders of the supply may be stated either as a supply curve, SS' of section B of Figure 1, or as part of the total demand curve, $D_tD'_t$; and the equilibrium price is then given either by the intersection of DD' and SS', or of $D_tD'_t$ and Q_t. This method of expressing the current supply curve as part of the demand curve was first suggested by Wicksteed[3], and was followed by Holbrook Working[4] and other pioneers of price analysis.

When statistical price analysts relate the total supplies on the market in a succession of periods to the prices prevailing in each of those periods, and determine a curve describing that relationship, it is thus the curve of total demand, $D_tD'_t$, which they obtain, rather than the traditional demand curve of economic theory, DD'. If the total supply of the commodity cannot be changed within each period with which they are dealing, in response to the prices of that period, and if they have made adequate statistical allowance for price level, population growth, changes in consumers' income, and other factors which may tend to shift the level or slope of the

2. Mordecai Ezekiel, Statistical Analyses and Laws of Price, Quarterly Journal of Economics, 43, pp. 199–214. 1928.

3. Philip H. Wicksteed, The Common Sense of Political Economy, pp. 498–544. 1910.

4. Holbrook Working, Factors Determining the Price of Potatoes in St. Paul and Minneapolis, University of Minnesota, Agricultural Experiment Station, Tech. Bul. 10, p. 17. 1922.

total demand curve, then their analyses will reveal quite accurately the slope and position of the curve $D_tD'_t$. It is possible to measure the curve DD' separately, or the curve SS', but the determination of each requires a separate study, with a different series of quantity data instead of the total quantity. In the subsequent portions of this paper, the term "demand curve" will be used to refer to the total demand curve, $D_tD'_t$, rather than to the purchasers' demand curve, DD'.

Where a commodity is non-perishable (such as cotton or wheat), a large part of the reservation demand may be for storage rather than for other disposition. In such cases, a low price will tend to reduce the supply for sale in the current period, but to increase the total supply on hand in the next period. At the same time, the price paid in one period may influence the quantity that will be produced in the next succeeding period. These two relations are shown in section C of Figure 1. Here $D_tD'_t$ is the demand curve for the current period, as before. SS', however, is the supply curve for quantity produced in the *next succeeding* period in response to price in the previous period. The horizontal distance from SS' to $S_tS'_t$ represents the carryover of stored supply from the current period to the succeeding period, in response to the price of the current period. Thus, for a price of OP_0, new production will supply the quantity OQ_1 in the next period, while the quantity $Q_1Q'_1$ will be carried over in storage, giving a total supply of OQ'_1. This total supply in the subsequent season, in response to the prevailing price in the current season, is given by the total supply curve $S_tS'_t$. Where the negative variation in carryover in response to price is larger than the positive variation in production in response to price, the total supply curve may even be negative in slope, rather than positive as usually assumed. Even when this occurs, however, the total demand curve, composed of the two negative elements of buyers' demand and sellers' reservation demands, will always be more elastic than the total supply curve, composed of the negative element of carryover and the positive element of newly-produced supply. When the term "supply curve" is used hereafter in this paper, it will be the curve of total supply, $S_tS'_t$, which is thus designated.

RESTATEMENT OF THE THEORY OF NORMAL PRICE

The normal price is that price at which the market price would tend to settle over a period of time long enough to bring quantities demanded (by purchasers) and quantities produced into an equilibrium. Traditional theory assumes that under static conditions (and under pure competition) this equilibrium would tend to be reëstablished, following any accidental disturbance. For those commodities where there is an appreciable time interval between a change in price and the change in production in response to that change in price, the cobweb theorem shows that the series of reactions may be quite complex.

The upper portion of Fig. 2 shows the relations between demand and subsequent supply for the special case of a commodity where a change in price in one period does not affect production until the next period but does completely determine supply in that period. The (total) demand curve is represented by $D_tD'_t$; it shows the schedule of prices received in period 1 for varying supplies available in period 1. The (total) supply curve is represented by $S_tS'_t$; it shows the schedule of quantities available in period 2 for varying prices paid in period 1.

Altho this figure is drawn in two dimensions — prices and quantities — it sets forth the relations of three variables. In the case of a current market, quantity bought must equal the quantity sold, for both quantities relate to the same period and are identical. In Figure 2, however, this identity no longer holds. OQ_1 is the quantity which sets the price in period 1; OQ_2 is the quantity (in period 2) called forth by that price. Altho only one price — P_1 — is involved, two distinct and different quantities are represented — OQ_1 and OQ_2 — and there is no *mathematical* reason why they must be identical. Instead, the cobweb theory reveals the series of reactions which may result from such situations, and demonstrates

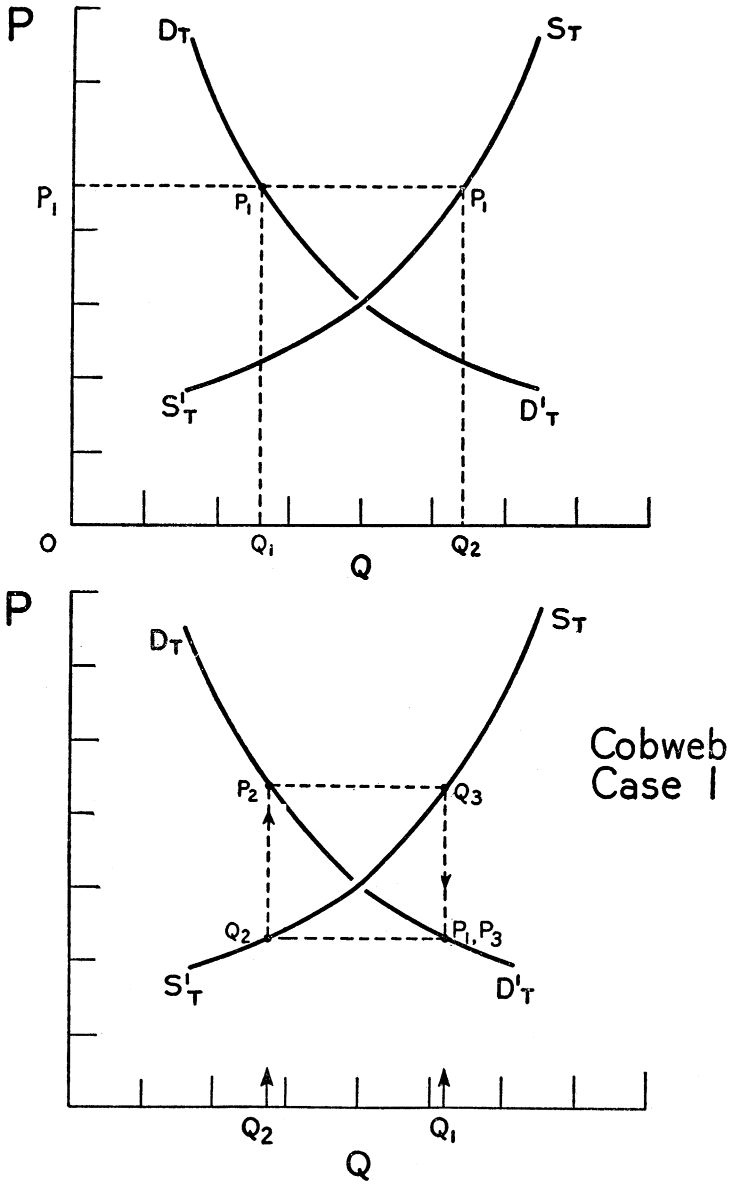

P
D_T
S_T
P_1
P_1
P_1
S'_T
D'_T
O
Q_1
Q_2
Q
P
D_T
S_T
Cobweb
Case I
P_2
Q_3
Q_2
P_1, P_3
S'_T
D'_T
Q_2
Q_1
Q

FIGURE 2

how and under what conditions equilibrium may be established. Since the two curves of Figure 2 exist in different time dimensions, they are not drawn intersecting, but rather lapping over one another without real contact.

The "Cobweb Theory"

The phases of the cobweb theory which have already been stated by others may first be briefly summarized:

Case 1, continuous fluctuation. In the lower portion of Figure 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 gives a high price, P_2, where it intersects the supply curve. 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 that in the first, 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 case has been designated the "case of continuous fluctuations."

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 Fig. 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

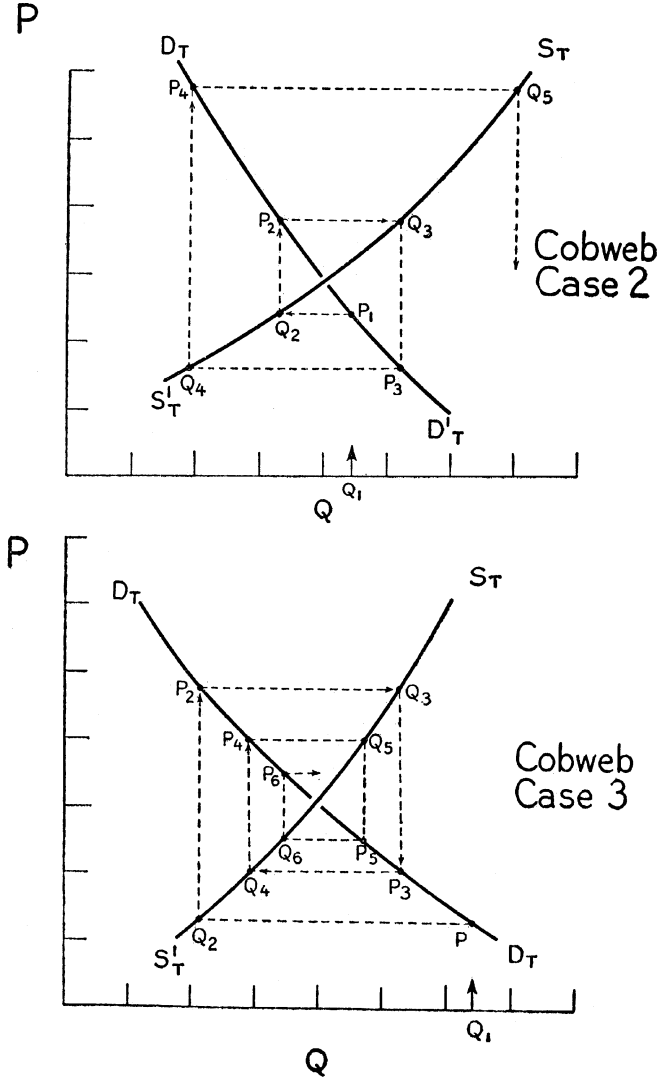

P
D_T
S_T
P_4
Q_5
P_2
Q_3
Cobweb Case 2
P_1
Q_2
Q_4
P_3
S'_T
D'_T
Q_1
Q
P
D_T
S_T
P_2
Q_3
P_4
Q_5
P_6
Cobweb Case 3
Q_6
P_5
Q_4
P_3
Q_2
P
S'_T
D_T
Q_1
Q

FIGURE 3

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, etc. 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. The case has been designated the "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. 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 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. The case has been designated "the case of convergent fluctuation."

To this point this paper has merely reviewed the points developed in earlier papers on the theory of price analysis and on the cobweb theory.[5] As thus developed, the cobweb theory explains swings in production and price in successive

5. Leontief, loc. cit., has shown that in cases where the supply curve and the demand curve are of erratic shape, with marked changes in elasticity along one or both curves, the cobweb reaction may be convergent at some points on the curves, and divergent at others. Such cases are a mixture of the three simple types summarized here.

production periods, but does not fully explain the long cycles observed in many commodities. The following portions of this paper present a further extension of the cobweb analysis that may be useful as a theoretical framework for the investigation of such long cycles.

Case 1a, two-period lag in supply, continuous fluctuation. 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 Fig. 4 shows it for Case 1, as Case 1a.

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 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 4, as Case 3b.

Here three initial supplies are assumed: Q_1, very small;

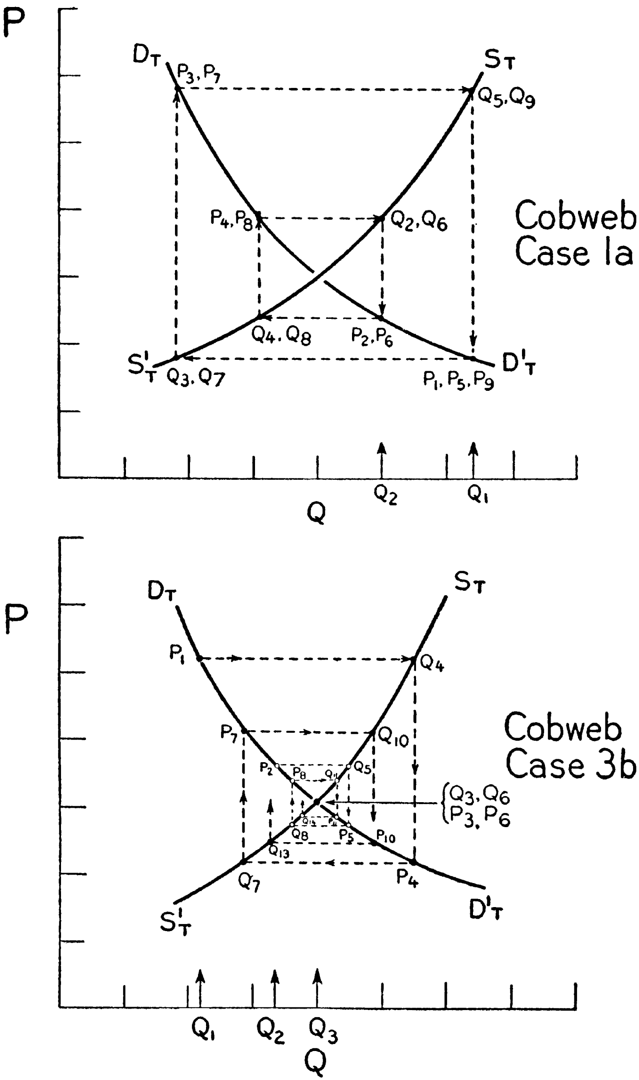

P
D_T
S_T
P_3, P_7
Q_5, Q_9
P_4, P_8
Q_2, Q_6
Cobweb
Case 1a
Q_4, Q_8
P_2, P_6
S'_T
Q_3, Q_7
D'_T
P_1, P_5, P_9
Q_2
Q_1
Q
D_T
S_T
P
P_1
Q_4
P_7
Q_{10}
Cobweb
Case 3b
P_2
P_8
Q_5
Q_3, Q_6
P_3, P_6
Q_8
P_5
P_{10}
Q_{13}
Q_7
P_4
D'_T
S'_T
Q_1
Q_2
Q_3
Q

FIGURE 4

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. A time-series chart of prices and production in the successive periods shown in Figs. 2 to 4, reveals more clearly the cyclical character of the resulting processes, as shown in Fig. 5. 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.

While it is evident that these synthetic time series have been constructed under highly rigid assumptions, it is interesting to compare them with some actual price and production cycles, as shown in Figs. 6 and 7. Fig. 6 shows the prices of cows and cattle corrected for changes in wholesale prices; Fig. 7, hog prices stated as a ratio to the price of corn, that is, the number of bushels of corn that can be bought with a hundred pounds of hogs. The changes in the adjusted prices of cattle and milk cows both reflect the underlying cycle in cattle numbers. The similarities are evident; it is also apparent that the actual cycles are more irregular, both in length and in shape, than are the cycles based upon the fixed periods of the theory.

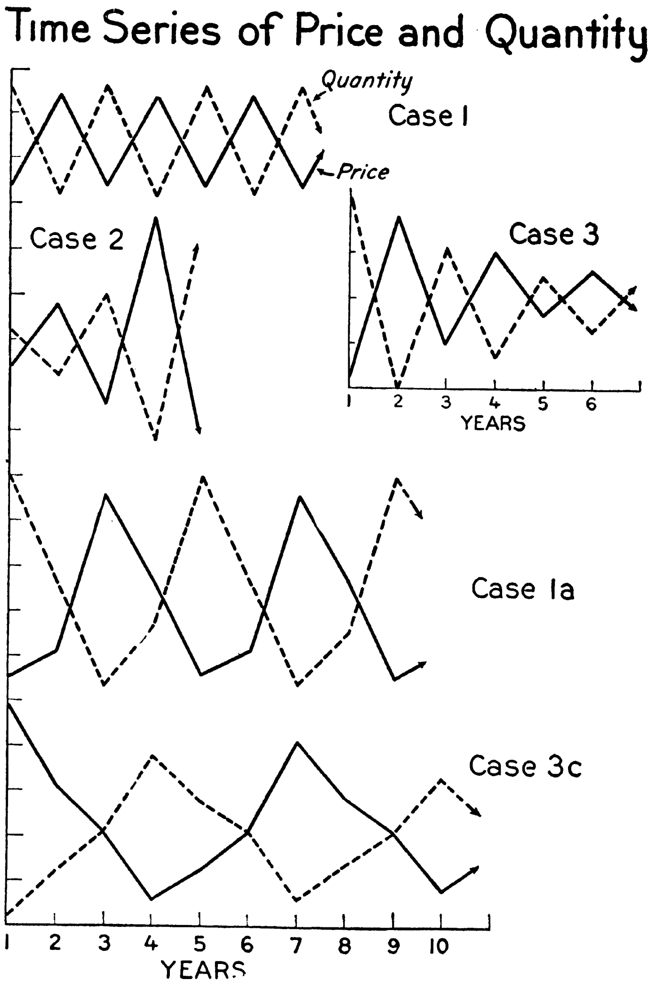
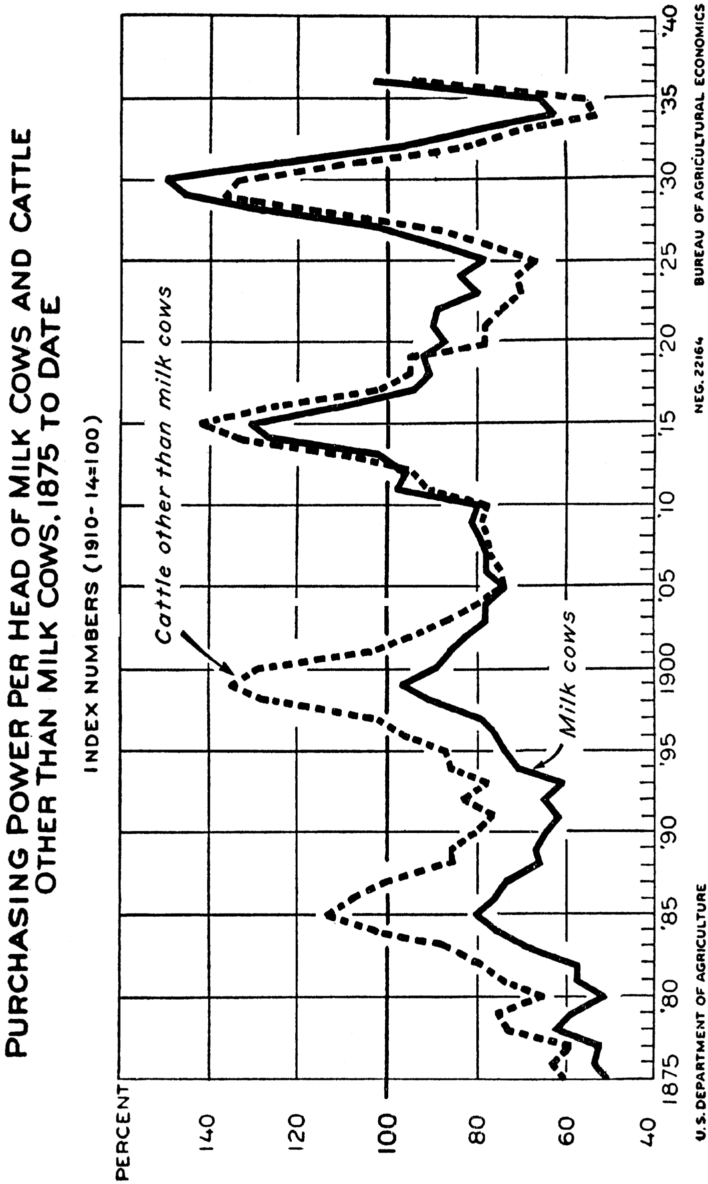
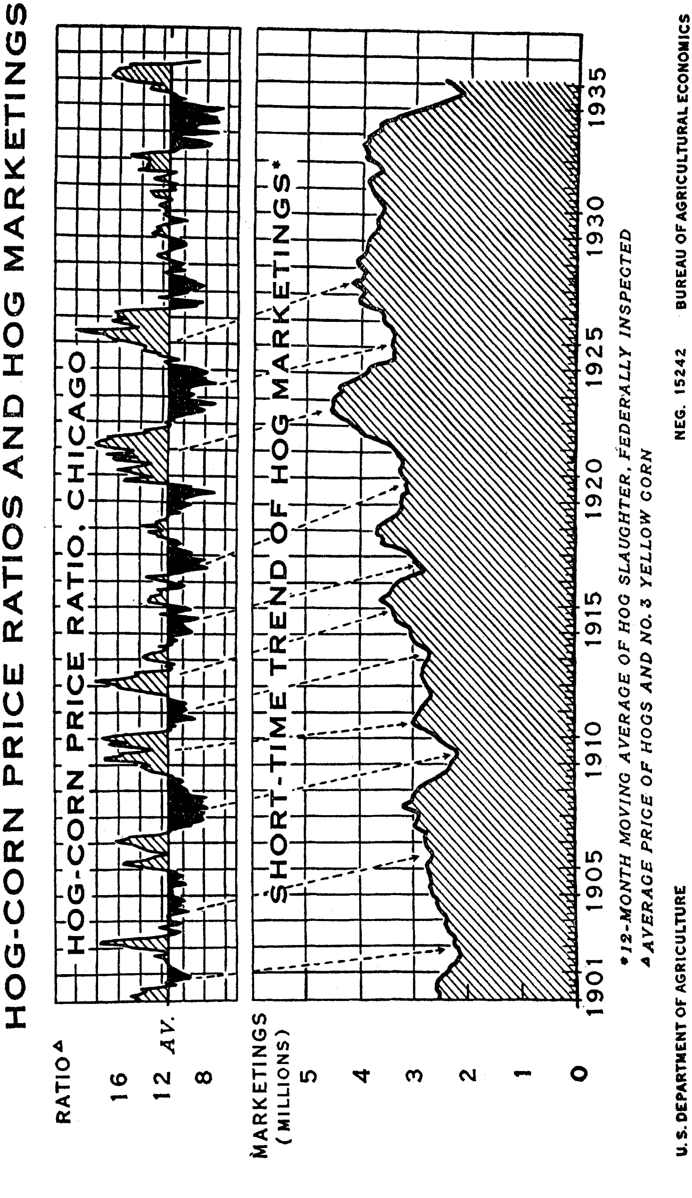

Time Series of Price and Quantity
Quantity
Case I
Price
Case 2
Case 3
1 2 3 4 5 6
YEARS
Case Ia
Case 3c
1 2 3 4 5 6 7 8 9 10
YEARS

FIGURE 5


PURCHASING POWER PER HEAD OF MILK COWS AND CATTLE OTHER THAN MILK COWS, 1875 TO DATE
INDEX NUMBERS (1910-14=100)
PERCENT
140
120
100
80
60
40
1875
'80
'85
'90
'95
1900
'05
'10
'15
'20
'25
'30
'35
'40
Cattle other than milk cows
Milk cows
U.S. DEPARTMENT OF AGRICULTURE
NEG. 22164
BUREAU OF AGRICULTURAL ECONOMICS


HOG-CORN PRICE RATIOS AND HOG MARKETINGS
HOG-CORN PRICE RATIO, CHICAGO
SHORT-TIME TREND OF HOG MARKETINGS*
RATIO▲
16
12 AV.
8
MARKETINGS (MILLIONS)
5
4
3
2
1
0
1901
1905
1910
1915
1920
1925
1930
1935
*12-MONTH MOVING AVERAGE OF HOG SLAUGHTER, FEDERALLY INSPECTED
▲AVERAGE PRICE OF HOGS AND NO. 3 YELLOW CORN
U.S. DEPARTMENT OF AGRICULTURE
NEG. 15242
BUREAU OF AGRICULTURAL ECONOMICS

Limitations of the Cobweb Theory

The cobweb theory can apply exactly only to commodities which fulfill three conditions: (1) where production is completely determined by the producers' response to price, under conditions of pure competition (where the producer bases plans for future production on the assumption present prices will continue, and that his own production plans will not affect the market); (2) where the time needed for production requires at least one full period before production can be changed, once the plans are made; and (3) where the price is set by the supply available. Obviously commodities where either price or production is set by administrative decisions (i.e., where monopolistic competition prevails), or where production can respond almost immediately to changed demands, cannot be expected to show the cobweb reaction.

Even for the commodities which approximately fulfill the assumptions, however, the theory must be limited. In many commodities farmers can do little to increase their future production, once they have made their initial commitment in acres seeded or in animals bred. But altho they cannot increase, they can reduce at any time until the product is finally marketed, by plowing up portions of the crop or letting it go unharvested, by slaughtering breeding stock, or by slaughtering pigs young instead of fattening them. There is thus in practice some elasticity of response left, on the downward side at least.

A further difficulty arises from the fact that few commodities show clearly marked one-period, two-period, or three-period supply reactions. In many farm commodities, changes in acreage are partly influenced by prices of the preceding year, and partly by those of two years before. In other commodities, such as hogs, not only the price of the commodity itself, but the price of raw materials for its production, such as corn, may be equally important.[6]

An even more serious limitation is that imposed by natural

6. Louis H. Bean, "The Farmers' Response to Price," Jour. Farm Econ., XI, pp. 368–385, especially page 385. July, 1929.

conditions affecting production. Crop production is dependent upon yield per acre as well as acreage; and yields are greatly influenced by the weather. In the past, yields and acreage have been about equally important in influencing cotton production, but yield changes have been far more important than acreage changes in corn. In other crops, such as tobacco, acreage varies much more than yield.[7] Variability in yield may result in a very large crop when acreage has been sharply reduced, or vice versa.

Unusual weather may occasionally change what would otherwise be a large crop to a normal one, and so restore prices to a point where subsequent variation will be slight — until another abnormal yield is secured. Most of the time, however, natural variations may tend to result in unduly high or unduly low production, and thus set a new cycle of response in reaction. 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 over a considerable number of commodities.

Another difficulty arises from the fact that actually production may not swing from very high to very low, even with a one-year response. Analyses of acreage response for various crops show that there is a limit to the per cent farmers will increase their acreage in any single year, so that even with a one-year response period, several years of successive increase in acreage may be required before very high prices are reflected in very high production. A very large contraction in acreage can be made in a single year, however, so that on the down side a single year of very low prices may be fol-

7. Louis H. Bean, "Some Limitations to the Control of Agricultural Production in the United States," American Coöperation, American Institute of Coöperation, 1932, pp. 461–465.

lowed by a great contraction in acreage. Similarly, in industries producing products with a long life, such as ships or houses, price is not set by the current production, but by current production added to the existing stock, and the current production may be quite small compared to that existing supply. In such cases price affects subsequent *additions to* supply, but *total supply* affects the price. The cobweb theory would need to be further extended and modified to apply to such cases.

Finally, there is no commodity for which the third condition — that the supply alone sets the price — is completely fulfilled. There are many commodities, especially farm products, whose prices ordinarily show larger variations due to changes in supply than to all other influences combined; yet their prices are also influenced by changes in the supply of competing products, changes in the prosperity or income of consumers, and changes in institutional factors affecting their market, such as tariff quotas, freight rates, weather conditions, and even style changes. Under unusual conditions, as during the years from 1931 to 1934, these forces which shift the position of the demand curve may far outweigh changes in supply as determinants of commodity prices, even for articles such as potatoes where a slight change in supply produces a disproportionately large change in price. In between periods of great economic upheaval, as from 1900 to 1913, or from 1922 to 1929, these shifts in demand may be relatively slight or regular, and it is during such periods that any underlying tendencies to cyclical reactions in individual products would be most clearly revealed.

An Illustrative Case from Actual Data

The difficulties which arise in applying the cobweb analysis to actual commodity data may be illustrated by the data for potato production, given in Table 1. The farm price for the crop season has been 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

TABLE 1. — POTATO ACREAGE, YIELD, PRODUCTION, AND PRICE: 1921 TO 1936

Crop Year[1]	Acreage	Yield per Acre	Production	Average Farm Price	Wholesale Price Level	Deflated Farm Price
	1000 Acres	*Bushels*	*Million bu.*	*¢ per bu.*	*1926 = 100*	*¢ per bu.*
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[2]	132.5

[1] July to June, inclusive.
[2] On basis of first ten months.
Source: Bureau of Agricultural Economics.

Fig. 8. This gives two points for each year, shown as dots and hollow squares, respectively. The dot labeled "27," for example, has for coördinates the 1927 price and the 1927 production; the hollow square labeled "28," the 1927 price and the 1928 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.[8] The successive readjustments between production, price, and production are indicated by the dotted lines.

8. In drawing the curves, production has been regarded as the independent factor determining the dependent factor, price; and price as

This figure presents the potato data according to a one-year response analysis. Actually, potato acreage is influ-

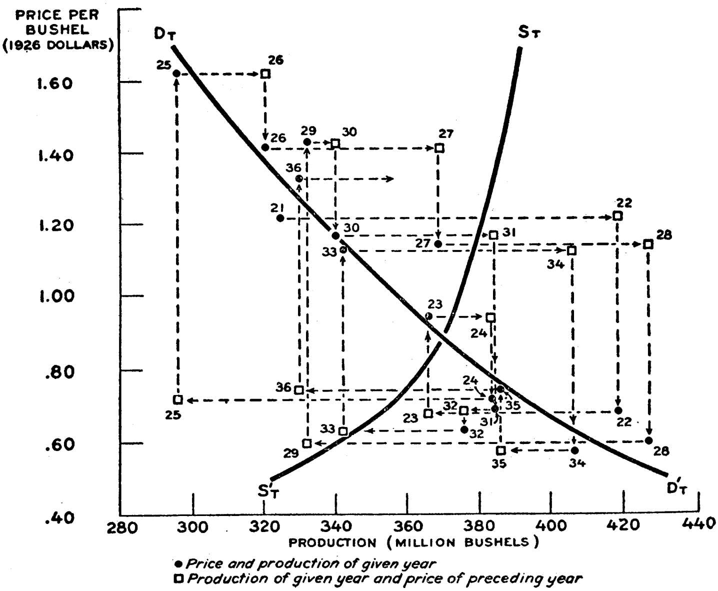


FIGURE 8

enced by prices of both one year and two years previous, so that an average of the two preceding prices would give a bet-

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 over-simplified 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.

ter explanation of acreage changes than the preceding price alone. Furthermore, potatoes are of the class where the increase in acreage in any one year is limited; Bean has shown that a 10 per cent increase is the limit of response, regardless of price.[9] This successive accumulation of increases is shown clearly on Figure 8. 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 down-side, however, single-year changes predominate, as from 1924 to 1925, 1922 to 1923, and 1928 to 1929. The line $S_t S'_t$ 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. Rather, it shows that at prices above 90 cents, production the next year will usually *increase*, tho within a limited range, while at prices below 90 cents, production the next year will usually decrease.

With these reservations in mind, Figure 8 may be examined for evidence of "cobwebbiness." There is an apparent tendency for the reaction to swing around the point of overlap. From 1921 to 1924 the cycle converged. In 1925 an exceptionally low yield per acre started a new cycle under way, which appeared to "dampen 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 (tho 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.

Not All Commodity Cycles are "Cobwebs"

Not all cyclical phenomena in individual industries are traceable to the "cobweb reaction." In durable or semi-

9. Louis H. Bean, "The Farmers' Response to Price," Jour. Farm Econ., Vol. XI, p. 380.

durable goods, the average length of service of the equipment, and the bunching of replacements in recurring periods, may give rise to a separate cyclical phenomenon which has been called "the replacement cycle." In producers' goods, especially in producers' goods several steps removed from the final product, such as in machine tools or die making, the demand for the producers' good may appear only when production of consumers' goods is increasing, and may disappear entirely when demand for the final product is stable. Similarly, demand for machinery to make the machines to make the final product may appear only when the demand for the final product is increasing at an increasing rate.[1] The derived character of the demand for producers' goods may thus give rise to cyclical phenomena in producers' goods' industries of a quite different character. Many recurring cycles in commodity prices may thus be found to be due to causes other than the cobweb reaction. The cobweb theorem as summarized here should be used as an hypothesis in studying the interactions of supply and demand only for those commodities whose conditions of pricing and production satisfy the special assumptions on which it is based, not as a blanket explanation of all industrial cycles.

Equilibrium Economics in the Light of the Cobweb Theory

The limitations just discussed apply, not to the cobweb theory as theory, but to the range within which it is a valid hypothesis. If we assume that, despite these limitations, the cobweb explanation will prove to be significant for many commodities, we may then ask how this theory affects economic theory as a whole.

Classical economic theory rests upon the assumption that price and production, if disturbed from their equilibrium,

1. J. M. Clark, "Business Acceleration and the Law of Demand; a technical factor in economic cycles," Journal of Political Economy March 1917; Ragnar Frisch, "The Inter-relation between Capital Production and Consumer-Taking," Jour. of Pol. Econ., October 1931, also replies by J. M. Clark in December 1931 and October 1932 issues.

tend to gravitate back toward that normal. The cobweb theory demonstrates that, even under static conditions, this result will not necessarily follow. On the contrary, prices and production of some commodities might tend to fluctuate indefinitely, or even to diverge further and further from equilibrium.

The equilibrium concept lies at the heart of classic theory. If prices and production do not converge rapidly to an equilibrium, then each industry may recurringly attract to it more labor and investment than it can use to advantage, and may leave that labor and equipment only partly utilized much of the time. In a series of industries, all showing individual cycles of the "cobweb" type, at any one time some will be operating at full capacity, or above the equilibrium point; others will be operating below the equilibrium point, at far below capacity; while others will be operating near the equilibrium point, but below the capacity installed at their recurring periods of over-expansion. For the whole series of industries combined, the installed capacity will materially exceed the portion that is in use at any one time; and the workers, trained for service in individual industries and prevented by various frictions from shifting readily into other industries, will always be partly unemployed. If many industries thus tend to develop — for occasional use — more labor and equipment than they need for normal output, labor and capital as a whole will never be fully utilized. If many commodities are chronically varying *above* and *below* their individual equilibria, then the economic system will never organize all its resources for the most effective use, but will always be operating below the total installed capacity and with more or less unemployment. Even under the conditions of pure competition and static demand and supply, there is thus no "automatic self-regulating mechanism," which can provide full utilization of resources. Unemployment, excess capacity, and the wasteful use of resources may occur even when all the competitive assumptions are fulfilled. If enough commodities follow the cobweb form of reaction, competitive readjustments may fail notably to reach the most productive employment of resources.[2]

In seeking to explain the persistent existence of unemployment and excess capacities, modern economists have laid increasing emphasis on the failure of our economic society to provide the competition assumed in traditional theory, and have turned to the new theory of imperfect or monopolistic competition, or to examination of the balance between savings and the need for new investment,[3] as theoretical explanations of the existing situation. From the foregoing discussion, however, it appears that even in those areas of the economic system where reasonably effective pure competition still prevails, cobweb cycles may prevent the system from reaching its most effective utilization of resources. Where competition is absent or monopolistic, we must study the other ways in which production and price are controlled; where pure competition is present, we must examine the mechanism and sequence of price and production reactions to determine whether they do work effectively toward an optimum adjustment.

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2. For a different approach to under-utilization of resources, note Alvin H. Hansen, Mr. Keynes on Underemployment Equilibrium, Jour. Pol. Econ., XLIV, p. 667. 1936.

3. John Maynard Keynes, General Theory of Employment, Interest and Money.