Volume Title: Production Trends in the United States Since 1870

Volume Author/Editor: Arthur F. Burns

Volume Publisher: NBER

Volume ISBN: 0-87014-022-1

Volume URL: http://www.nber.org/books/burn34-1

Publication Date: 1934

Chapter Title: Cycles in the Growth of Industries

Chapter Author: Arthur F. Burns

Chapter URL: http://www.nber.org/chapters/c2264

Chapter pages in book: (p. 170 - 248)

## Chapter V

# CYCLES IN THE GROWTH OF INDUSTRIES

THE tendency of individual industries to grow at a declining rate has been an outstanding expression of the progressiveness of the American economy. This tendency indicates that, taking a long view, a fairly regular and orderly transformation in the pattern of national production has accompanied the rapid growth in its volume. Nevertheless, the march of retardation has not been continuous in any of the industries covered in our survey.[1] The purpose of this chapter, therefore, is to search for principles of order in the undulatory movements that apparently are always found in the slopes of the secular trends of production and at times are so sharp as to be expressed in negative slopes. We have previously spoken of these undulatory movements as 'trend-cycles'.[2]

The earlier study of the decade-by-decade correlation between the rates of growth of industries has already foreshadowed that there may be a fair degree of similarity in the trend-cycles of our series.[3] It will now be seen that there is actually a considerable degree of concurrence in the trend-cycle movements of nonagricultural industries, despite numerous differences in their trend-cycle patterns and amplitudes; that this concurrence creates a strong presumption that a long-term rhythm has been pervasive in the American

[1] See pp. 107–8.
[2] See p. 48.
[3] See pp. 87–90.

economy since the Civil War; that the trend-cycle rhythm of national industry has been accompanied by a similar cycle in the degree of divergence of production trends; and that each time the national economy has experienced an exceptionally rapid rate of advance, its progress has been checked by a business depression of great severity. These findings indicate implicitly that the pattern of national industry has undergone fairly regular transformation even when our view is restricted to periods of intermediate duration, and that the extent of shifts in the pattern of national industry has tended to vary with the rate of progress of the general economy.

## I. MEASUREMENT OF TREND-CYCLES

The decade rates of growth of the individual series are the basic data of this study of trend-cycles. The preceding chapter has established that the decade rates generally have a definite drift and that the drift is downward in a preponderant number of the series. Since the degree of drift of the decade rates varies from series to series, it is best to eliminate the drift before the oscillations of the decade rates of the individual series are subjected to analysis. In order to eliminate the drift, it must first be measured: this has been effected by fitting an exponential curve to the decade rates of each series.[4] The drift of each series was then eliminated by expressing the decade rates of the series as plus or minus deviations from the ordinates of the exponential curve fitted to the decade rates. These plus or minus deviations trace out the major oscillations in the percentage rate of growth of production—a correction having been made for the general

[4] The equations of the exponential curves were yielded by the study in the last chapter of retardation in the growth of industries. Exponential curves generally yielded 'good fits'; in the few cases where they did not, experimentation showed that the use of other types of curves would not alter any conclusion of importance. Variation in the type of curve used to measure the drift of the decade rates would have 'improved' the results only slightly, while it might have cast on them a shadow of doubt.

drift in the percentage rate of growth. The plus or minus deviations of the decade rates are the technical form in which trend-cycles are considered in this chapter.

The exact meaning of the technique will be grasped most easily if the decade rates of a given series be regarded as quinquennial observations on the 'slope' of the secular trend [5] of that series, and if the corresponding ordinates of the exponential curve fitted to the decade rates of the series be regarded as quinquennial observations on the slope of the primary trend of the series. The meaning is less simple, but not less definite, if the decade rates of a given series be regarded as measures of the average slope over decade periods of the secular trend of that series, and if the corresponding ordinates of the exponential curve fitted to the decade rates of the series be regarded as measures of the average slope over decade periods of the primary trend of the series. On the basis of either interpretation, a positive deviation of a given decade rate of a given series from an exponential curve fitted to the decade rates of the series denotes that the secular trend advanced more rapidly at the given time than the primary trend, a negative deviation denotes that the secular trend advanced less rapidly than the primary trend, and a zero deviation denotes that the secular trend advanced at the same rate as the primary trend. If the slope of the secular trend of a series correspond throughout the period to the slope of the primary trend, trend-cycles are non-existent; but if the slope of the secular trend diverge from the slope of the primary trend, trend-cycles do exist.

It will be noticed that trend-cycles are not considered in this chapter in the same way as in other investigations of

[5] Concerning the distinction between secular and primary trends, see pp. 44–6. In the inquiry of Chapter IV, the primary trends are conceived of, in effect, as parabolas fitted to the logarithms of production data; this is practically implicit in the use of exponential curves fitted to decade rates (see Ch. IV, sec. I).

this subject.[6] Ordinarily, a peak in the trend-cycle curve of a series denotes a maximum positive deviation of the ordinate of secular trend from the ordinate of primary trend of the volume of production, and a trough a maximum negative deviation. In our inquiry a peak in a trend-cycle curve denotes a maximum positive deviation of the *slope* of the secular trend from the *slope* of the primary trend of the volume of production, and a trough a maximum negative deviation. While trend-cycles are ordinarily considered as long waves in the absolute volumes of production, they are considered in this study as long waves in the percentage changes in the volumes of production. The relation between the two can be expressed exactly in the case of a hypothetical series of trend-cycles of absolute production volumes which have a sine-curve movement: here the trend-cycles in the percentage change curve will lead the trend-cycles in the absolute volume curve by one quarter of a period (or cycle). We may consider this sort of relationship as holding only roughly in the case of our series, inasmuch as our trend-cycle curves are not sine curves and our trend-cycle observations relate to quinquennial dates.[7]

There is another point, in part methodological and in part terminological, which must be carefully noted in connection with our technique. Ordinarily, a 'cycle' is taken to mean a recurrence of plus and minus phases, the idea of recurrence being crucial in the customary conception. Except when the term 'cycle' is used in a restricted historical sense, the idea of recurrence involves the notion of continuity and the expectation that a given pattern of events will extend into the

[6] The most important studies are by Kondratieff, Kuznets, and Wardwell. See Kuznets, *Secular Movements*, cited above, Chs. III-IV; and Wardwell, *An Investigation of Economic Data for Major Cycles* (Philadelphia, 1927). Kondratieff's investigations are presented most conveniently in "Die Langen Wellen der Konjunktur," *Archiv für Sozialwissenschaft und Sozialpolitik*, December, 1926.

[7] See p. 40, note 12.

future. The idea of recurrence has a sound logical basis in only certain types of theory, such as that oscillations in the economy are caused by some oscillatory movement 'outside' of the economic system, or that the oscillations arise out of the internal conditions of economic life and are self-generating. The idea of recurrence will not have a firm rational support if oscillations are considered to be initiated by accidents; for, although accidents are likely to occur in the future as in the past, they may be more or less frequent, and for a considerable period may be self-neutralizing. Inasmuch as towards the close of this chapter the conjecture is ventured that an upward trend-cycle movement is likely to originate, among other ways, in accidental causes, the propriety of using the term 'trend-cycle' throughout the discussion may be called into question.

There is little to be gained from an attempt to fix the most appropriate denotation of such a common word as 'cycle'. However, it is doubtful if restrictive notions of type of causation ought to be allowed to enter into our conception of a 'cycle' at a time when the basic forms of economic movement are still but vaguely known. From a statistical standpoint, the essential nature of a 'cycle' consists in the existence of plus and minus phases in one or more processes (or series). What the statistician may have to say about such 'cycles' is always of some importance in the study of the economic history of specific industries. From the standpoint of general economic theory, such plus and minus phases are of little or no importance when they are uncorrelated; but they are of considerable importance when diffused and synchronous in high degree—that is to say, when they suggest the operation of common causes. Since the idea of recurrence implies not only the operation of common causes, but as well definite types of causal sequence, it is desirable, in the initial stage of fact-finding, to strip the concept of 'cycle' from this idea.

This is not to deny the importance of the idea of recurrence, which must obviously be the basis of any rational forecasting, but merely to insist that the initial task in a theoretical inquiry into 'cycles' is to determine the degree of concurrence in the plus and minus fluctuations of a group of economic elements that are related a priori. The present study proceeds from the conception that a high degree of concurrence in such plus and minus fluctuations defines the existence of an economic 'cycle'.

## II. A GENERAL TREND-CYCLE IN PRODUCTION

The data of the trend-cycles of the individual production series are presented in Appendix A, Table 47. If the reader glance at this table, he will note that the trend-cycles of the series differ very considerably in pattern and amplitude; so it cannot be presumed that a given set of causes has operated exclusively and uniformly through the trend-cycles of all branches of industry. The trend-cycles of the individual series may, however, be viewed as resultants of two sets of causes: those which have operated at a uniform rate through all the members of the production 'system', in the sense of tending to produce common effects in these members; and those which have operated at random on individual industries or groups of industries, in the sense of tending to produce different and random effects (the individual causes operating at random possibly including among them, however, any of those operating at a uniform rate). From this point of view, our problem becomes to extract a common trend-cycle, if there be such a thing, from the mass of observations on trend-cycles; to obtain, if we can, measures of the effects of the common set of causes which may pervade the ensemble of production trend-cycles.

If a set of common causes, variable in time, operate uni-

formly through the trend-cycles of individual industries, their effects will be registered in the movements of the averages of the trend-cycles, even though random factors operate simultaneously with the set of common causes. We may, then, approach our problem by studying the averages of the trend-cycle observations of the individual series at quinquennial dates. The medians of the trend-cycle observations of four groups of series ('all' series, basic series, nonagricultural series, and basic nonagricultural series) are plotted in Chart 4 and recorded in Table 30.[8] It will be noticed that the four

Table 30

MEDIANS OF TREND-CYCLE OBSERVATIONS AT CENTRAL DECADE YEARS, FOR SEVERAL GROUPS OF PRODUCTION SERIES

(Unit: one per cent)

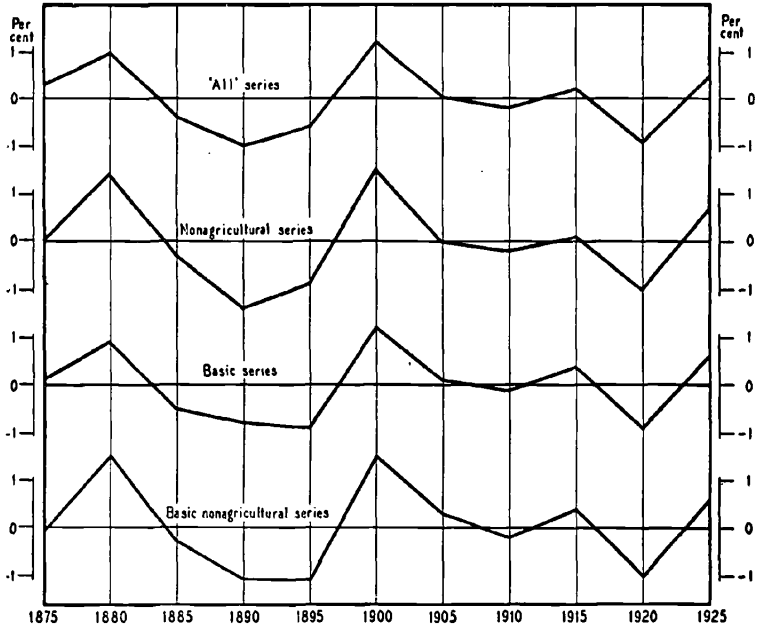
| Central decade year | Medians of trend-cycle observations | | | |
|---|---|---|---|---|
| | 'All' series | Non-agricultural series | Basic series | Basic non-agricultural series |
| 1875 | 0.3 | 0.0 | 0.1 | −0.1 |
| 1880 | 1.0 | 1.4 | 0.9 | 1.5 |
| 1885 | −0.4 | −0.3 | −0.5 | −0.3 |
| 1890 | −1.0 | −1.4 | −0.8 | −1.1 |
| 1895 | −0.6 | −0.9 | −0.9 | −1.1 |
| 1900 | 1.2 | 1.5 | 1.2 | 1.5 |
| 1905 | 0.0 | 0.0 | 0.1 | 0.3 |
| 1910 | −0.2 | −0.2 | −0.1 | −0.2 |
| 1915 | 0.2 | 0.1 | 0.4 | 0.4 |
| 1920 | −0.9 | −1.0 | −0.9 | −1.0 |
| 1925 | 0.5 | 0.7 | 0.6 | 0.6 |

[8] Since not all of the series go back to 1870, the medians for the several groups of series are based on a variable number of series in the early years. The composition of the several groups, for the central decade year 1890 and all following central decade years, is that given in Appendix A, Table 46, columns *e*, *f*, *g*, and *h*, except that series 49 and 50 are omitted for the central decade years 1920 and 1925. The composition of the groups for the cen-

lines of medians definitely trace out oscillatory movements. However, the movements of the medians cannot safely be

**Chart 4**

MEDIANS OF TREND-CYCLES OF SEVERAL GROUPS OF PRODUCTION SERIES




trusted to disclose the influence of a set of common causes operating through the production system; for our series cover

---

tral decade year 1875 is that given in columns *a*, *b*, *c*, and *d*. The composition for the central decade year 1880 differs from that for 1875 in including the following series in the several groups: 'all' series—73, 92, and 103; basic—73 and 92; nonagricultural—73, 92, and 103; basic nonagricultural—73 and 92. The composition for the central decade year 1885 differs from that for 1880 in including the following series in the several groups: 'all' series—17–20, 23, 35, 37–45, 74–82, 99, and 104; basic—18–20, 23, 36, 39, 43, 74, 78–80, 82–3, 99, and 104; nonagricultural—35, 37–45, 74–82, 99, and 104; basic nonagricultural—36, 39, 43, 74, 78–80, 82–3, 99, and 104.

only part of this system, and the averages may, therefore, reflect in considerable degree the accidental characteristics of our partial data. As presumptive evidence of a general trend-cycle in production, the similarity of the cyclical patterns of the several lines of medians is more significant than the oscillatory movements themselves. However, the fact that the medians relate to groups of series which overlap in considerable part may by itself account for the similarity in their movements.

It is essential that we use a technique better adapted than the method of averages to extract a common element from a mass of cyclical data which are only a 'sample' of their universe. One such method is to study graphically the trend-cycles of the individual series with a view to determining the degree of their covariation. This method suffers from the fact that the idiosyncratic elements in the trend-cycles of the various series may conceal any underlying similarities. However, if we resort to artifices of anonymity, such as arrays of trend-cycle observations or decils of trend-cycle observations, it will be possible to observe the series in the mass and at

---

Medians are used extensively in this chapter in averaging the trend-cycle observations of the individual series, because it was desirable to restrict the influence of extreme items—most often found in series of minor importance—on the averages. The medians were computed by taking an arithmetic mean of the middle three or four items, according as the number of series in the group was odd or even.

A few words are necessary about the manner in which the trend-cycle charts, especially those following for individual series, are to be interpreted. The quinquennial dates at the bottom of each chart are the central years of the decades to which the 'decade rates', adjusted for their drift, relate. It is natural to read the charts with reference to the areas on each side of the horizontal zero-line and also to the temporal location of the peaks and troughs. However, the latter method of reading is the more significant, for while a change in the type of curve fitted or in the length of period analyzed will almost always redistribute the plus and minus ordinates, the temporal location of the peaks and troughs will rarely be changed; the magnitude of the peaks and troughs may, of course, differ, but this is of secondary importance.

the same time largely eliminate the idiosyncratic elements in the trend-cycle movements of the series. Accordingly, the trend-cycle observations for 1875, the first of our quinquennial dates, were ranked from the lowest minus to the highest plus value, and nine decil values were then located.[9] Deciles were similarly determined for each of the ten following quinquennial dates. In all, then, eleven first deciles were obtained, eleven second deciles, and so on. Separate calculations of deciles were made for each of the four groups of series, for which medians alone were given above. The decil values are recorded in Appendix A, Table 48, and are shown graphically in Charts 5 to 8.[10] The first decil curve in these charts simply joins the first decil values at the several quinquennial dates, and similarly with the other decil curves. A given decil curve may, of course, be based directly on as many individual series as there are quinquennial dates.[11]

[9] The first decil states the trend-cycle value which exceeds one-tenth and is exceeded by nine-tenths of the trend-cycle observations, the second decil states the trend-cycle value which exceeds two-tenths and is exceeded by eight-tenths of the observations, and so on. The exact method used in determining the deciles was as follows: if a group consisted of, say, 75 series, the first decil was taken as the value of the 8.0 case, the second as the value of the 15.5 case, the third as the value of the 23.0 case, and so on. See S. Yang, "On Partition Values," *Journal of the American Statistical Association*, June, 1933.

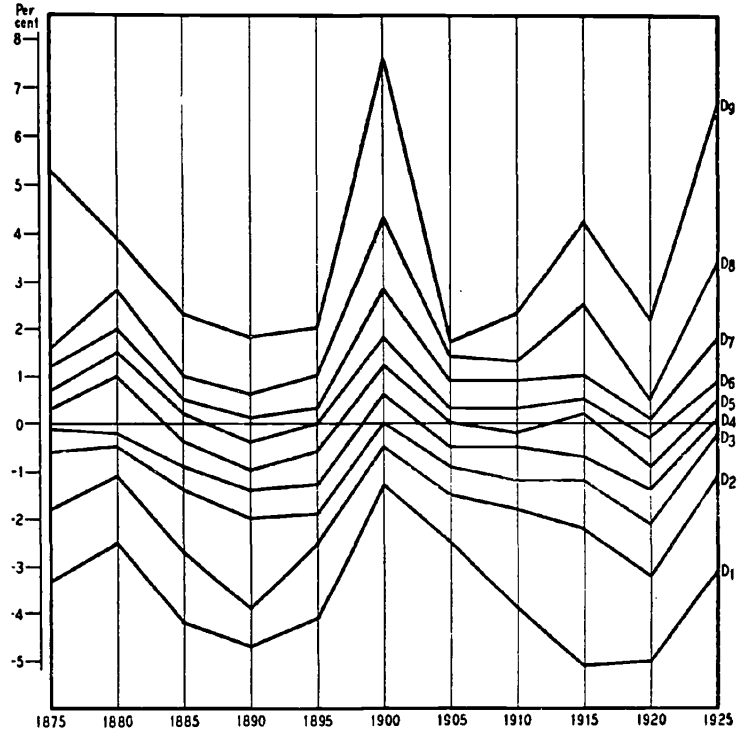
[10] The composition of the several groups of series is stated on pp. 180–1, note 8, Section 1 of the basic nonagricultural series being there designated simply as the basic nonagricultural group. Section 2 is the same as Section 1, but its deciles were computed, to use the example of note 9, by taking the values of the 7.5 case, 15.0 case, 22.5 case, and so on. This was done in order to reduce the influence of several 'misfitted' series on the deciles (see p. 191, note, point 4). Section 3 differs from Section 2 in that it omits building permits, total cement, rail consumption, and flaxseed consumption, from the calculations of deciles for the central decade year 1915 (see pp. 190–1, note 14, points 2 and 3). Section 4 differs from Section 3 in omitting for the entire period analyzed the following series: phosphate rock, silver, raw sugar consumption, building permits, coastal trade, postage stamps, tonnage entered and cleared. The propriety of originally including phosphate rock and silver in the basic nonagricultural group is questionable; as for the remaining five series, see Appendix C, III.

[11] The number of series contributing directly to a given decil curve may

The most important feature of the decil charts is the direction of the decil curves. If a set of common causes operating

**Chart 5**

DECILS OF TREND-CYCLES OF 'ALL' SERIES*




* The D's and their subscripts refer to successive decils.

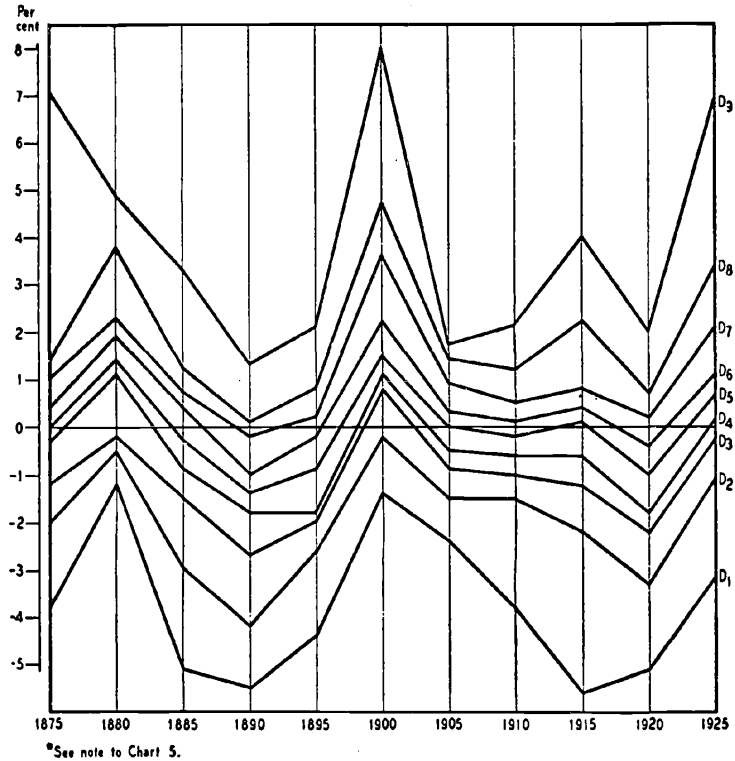
through a system of variables impart to it an upward fillip, the average level of the system will be raised, as will also the middle 20 per cent of the cases, taken as a unit, the middle 40 per cent, the middle 60 per cent, and so on. Thus, the

be even larger, since linear arithmetic interpolation was used in determining all of the decils except the fifth (median). See p. 182, note, for method of determining the medians.

fourth and sixth decils move upward between the central decade years 1875 and 1880 in Charts 6–8, but not in Chart

Chart 6

DECILS OF TREND-CYCLES OF NONAGRICULTURAL SERIES*



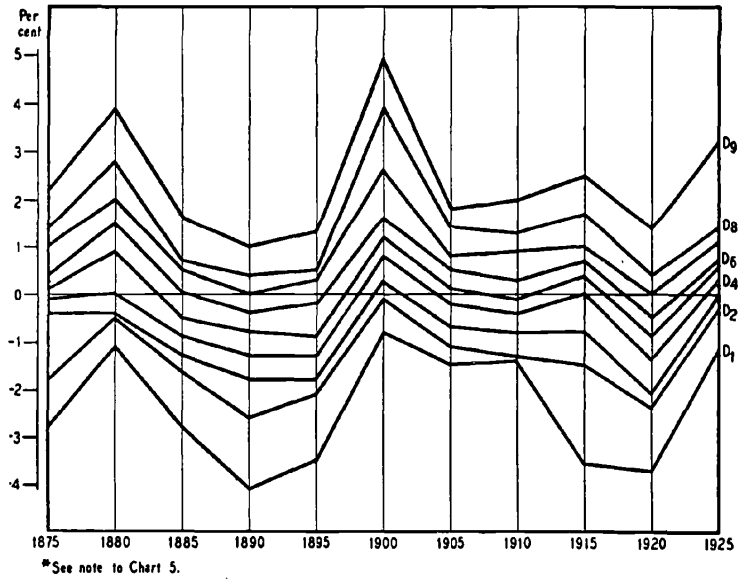

*See note to Chart 5.

5: this means that the middle 20 per cent of the trend-cycle observations, taken as a unit, show an upward movement in the first three charts, but not in the last. When all of the decils of a given group move in the same direction between successive time units, the evidence of the decil lines is in harmony with the evidence of the median line, and a shift in

the whole system of trend-cycle observations is indicated.[12] But whenever there is a generally irregular or fan-like arrangement of decil lines between successive central decade years, the evidence of the decil charts is in conflict with the

Chart 7

DECILS OF TREND-CYCLES OF BASIC SERIES*




*See note to Chart 5.

evidence of the median lines: it could not then be presumed that a set of impulses acted commonly through the trend-cycles of industries.[13] As the decil charts more nearly provide

[12] This would be more strictly accurate, were the lowest and highest values plotted with the decils. But such extreme values, being often erratic, are of little consequence, and might only confuse the picture.

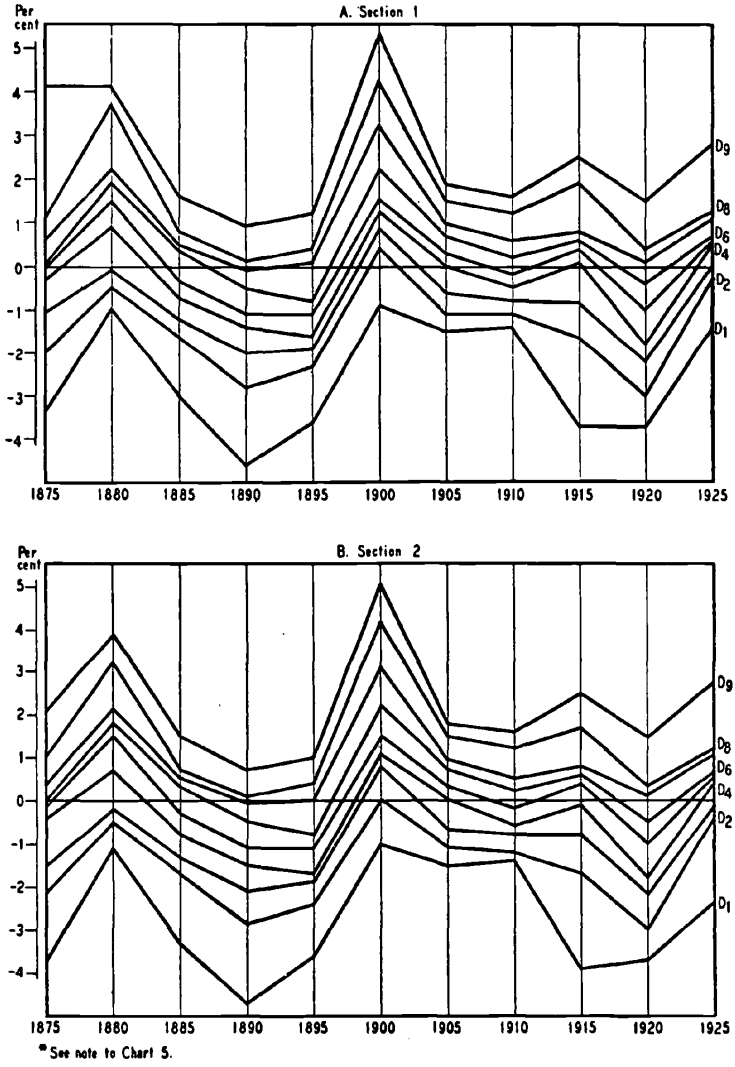
[13] An exception must be noted. One of the 'normal' concomitants of a change in the average level of the elements of a system may be a correlated (direct or inverse) change in the dispersion. If now the ratio of the change in the dispersion to the change in the average be very large, a fan-like arrangement of decil lines is possible. But the factor of dispersion can be 'controlled' by expressing the individual values in units of a dispersion measure and then proceeding to the decil analysis.

a composite picture of the movements of the entire system of trend-cycle observations, they reveal much more than the median lines.

The decil charts warrant careful study,—all the more so because the decil technique is a sensitive instrument when used on groups of the size here considered. It will be noticed that the degree of comovement in the direction of decil lines is rather high in all of the charts. But the 'parallelism' of decil lines is somewhat greater in the groups which exclude agricultural series than in those which include them, and in the groups which exclude non-basic series than in those which include them. The basic nonagricultural group, presented in four sections, is marked by greater regularity of decil lines than any other group. The sharp 'irregularity' in the first decil line between the central decade years 1875 and 1880, evidenced in Chart 8A, is purely technical and disappears in Chart 8B, which is based on a minor modification in technique. The persisting irregularity between the central decade years 1910 and 1915 virtually disappears in Chart 8C, as a consequence of dropping the few series relating to construction (an industry subject to special influences during this period) from the calculations of decils for the decade centered at 1915. Finally, almost perfect 'parallelism' emerges in Chart 8D, which excludes from the group analyzed seven rather dubious series, the reappearance of an erratic movement in the first decil line having no real significance. The set of decil charts plainly indicates that the basic nonagricultural group, which is the most homogeneous a priori is also the most homogeneous in fact; if the trend-cycles were of a random character, the basic nonagricultural group, containing fewer series than any other, would in all likelihood evidence the greatest irregularities in the movements of decil lines. Apparently, common impulses have operated through the members of the basic nonagricultural group.

## Chart 8

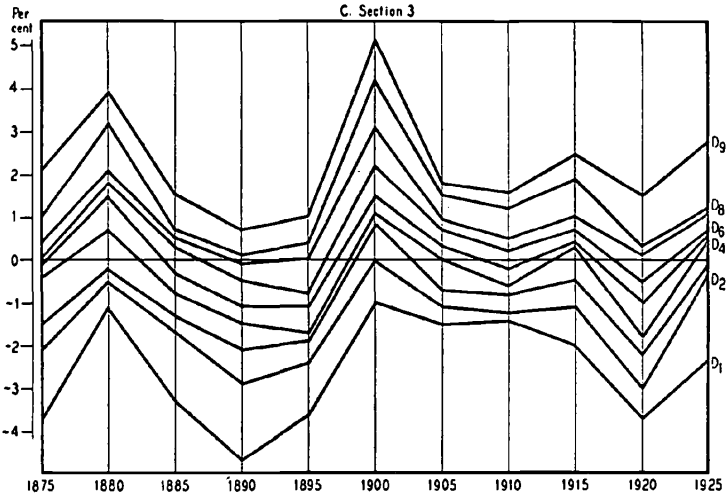
DECILS OF TREND-CYCLES OF BASIC NONAGRICULTURAL SERIES*

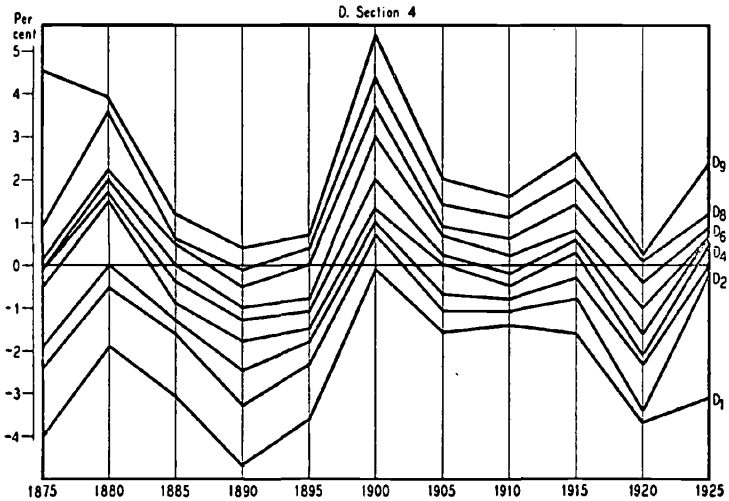



*See note to Chart 5.

## Chart 8 (cont.)

DECILS OF TREND-CYCLES OF BASIC NONAGRICULTURAL SERIES*




*See note to Chart 5.

The other groups are less homogeneous a priori, and also appear to be less homogeneous in fact.[14] Apparently, the influence of the commonly acting impulses has been obliterated in some part in these groups.

The trend-cycles of our production series have been analyzed up to this point on the hypothesis that they are resultants of common and individual factors. We may test this hypothesis by exploring another—to wit, that the trend-cycles of the series are independent, in the sense that they have no greater connection than the 'cycles' of series of dice throws. It will be perceived readily that decil lines of cycles of chance series, running over a period of time, will tend increasingly to approach horizontal straight lines as the number of chance

[14] The factors which make for the major 'irregularities' in the movements of decil lines of the various groups of series are easily located. (1) At the central decade years 1875 and 1880 the influence of agricultural series may be detected in the irregular behavior of certain of the decils in the groups including agriculture. An examination of the array of the trend-cycle values at the central decade year 1880 discloses that 8 of the 15 series in the 'all' series group (Chart 5) falling between the second and fourth decils are crops; and similarly, that 5 of the 13 series in the basic series group (Chart 7) falling beween the second and fifth decils are crops. (2) In all charts, except 8C and 8D, the movement of the decil lines is somewhat fan-like between the central decade years 1910 and 1915. This reflects the drastic change in the pattern of production, which was occasioned by the World War. The construction industry, in particular, suffered a severe setback at a time when other industries were expanding rapidly (see Chart 18); this was due to governmental restrictions on building during the War-years, and to the depressant influence of the capital loan market for some time after the War. Examining the group of nonagricultural series (Chart 6) at the central decade year 1915, we find that the 8 series having the lowest trend-cycle values include 7 series representing volume of construction or the production of building materials, that the lowest 11 include 9 'construction' series, and that the lowest 15 include 10 'construction' series. In the category of basic nonagricultural series (Charts 8A and 8B), we find that 4 of the 6 series having the lowest trend-cycle values relate to construction. It is rather significant that when construction series are eliminated from this group for the central decade year 1915, the degree of comovement of decil lines between the central decade years 1910 and 1915 is considerably augmented (see Chart 8C). (3) An obtrusive irregularity of the decil charts is the horizontal or upward movement between the central decade years 1915 and 1920 in the first decil curves of Charts 5, 6, 8A, and 8B. This is accounted for by the peculiar behavior of the construction industry (see Chart 18).

series becomes larger and larger; for with a very large number of series, the cyclical observations at any one date will form a frequency distribution similar to that at any other date, and a given decil for any one date will therefore tend to be identical with the corresponding decil for any other date. If the number of chance series were no more than, say, a hundred, the tendency for decil lines to be horizontal would not operate as strongly; but in this case,—no less than in the case of a very much larger number of chance series,—although any kind of decil chart would be possible, the possibilities would have varying degrees of probability. The probability of the decil lines moving in the same direction between two time units is less than the probability of an irregular arrangement of decil lines. Even if we assume that the probability of the decil lines moving in the same direction between two time units is ½, the probability of the decil lines moving in the same direction between successive time

---

Though the trend-cycle position of general industry was low during the decade centered at 1920, the lowest group of industries in that decade was still higher in most of the groups than the lowest group of industries, primarily associated with construction, during the decade centered at 1915 (compare Chart 8C). (4) Another irregularity in the detail of the decil charts is the downward or horizontal movement from the central decade year 1875 to 1880 in the ninth decil curves of Charts 5, 6, 8A, and 8D. This irregularity derives in large part from the sharp upward trend of several industries during the 'seventies, which is not taken account of adequately by the exponential curves fitted to the decade rates. The curves give poor fits in the early period of a few series—steel, antimonial lead, domestic lead, total lead, petroleum, and raisins (see Charts 15 and 17); and this is manifested in extremely high positive deviations at the central decade year 1875. The series which dominate the first decil at 1875 in Chart 8A are petroleum, domestic lead, and steel; the influence of these series disappears in Charts 8B and 8C as a result of a simple modification in the computation of decils (see p. 183, note 10); but the influence of these series reappears in Chart 8D, the total number of series having been reduced. (5) The minor irregularities between the central decade years 1890 and 1895 in Charts 7, 8A, 8B, and 8C are apparently due in some measure to several dubious series—those excluded from Chart 8D. To be sure, the dubious series are included in Charts 5 and 6 which are not marked by these irregularities; but these charts represent the largest groups we have analyzed, so that the influence of the dubious series is submerged.

units (the movement may be upward during some periods and downward during others) of a period consisting of eleven time units (the number of quinquennial dates covered) is only $\frac{1}{1024}$. 'Parallelism' in the direction of decil lines can arise under chance conditions, but the probability is so low that it may virtually be dismissed. In view of the high degree of 'parallelism' of the decil charts, it is very unlikely that the hypothesis of independence of trend-cycles is valid.

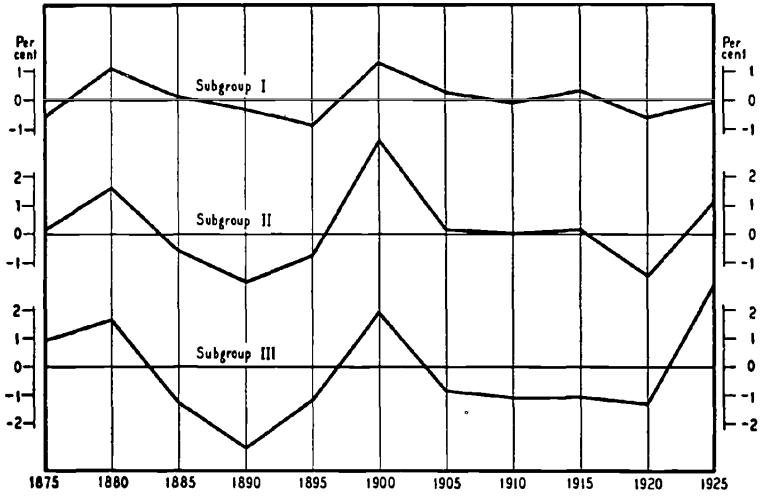
But there are two modified forms of this hypothesis which warrant some attention. First, suppose that common factors acted through the trend-cycles of one important section of the production 'system', but that the trend-cycles in the other sections were of a random character. In this case, considerable comovement of decil lines might be evidenced by a group of series whose members were drawn from these heterogeneous branches of industry. This hypothesis has already been tested in some part through our decil analysis of several groups of series. Strong indications have appeared that agricultural industries are subject to somewhat different trend-cycle influences than nonagricultural industries; and it is later shown that trend-cycles in agriculture are, in fact, quite erratic. There are portions, then, of the production system to which the apparently systematic factors making for trend-cycles do not extend.

The second modified form of the hypothesis of independent trend-cycles is more formal. Suppose that the production system consisted of a number of sections, each of which was subject to a set of common trend-cycle influences, but that the trend-cycles of any one section bore no relation to the trend-cycles of any other. If, now, one section had trend-cycles of exceptionally large magnitude, it would play a major rôle in determining the pattern of a decil chart comprising all of the sections, and a considerable 'parallelism' of

decil lines might result. One way of checking this possibility is to observe separately the trend-cycle patterns of groups of series having trend-cycle amplitudes of varying degree. Accordingly, the series in the nonagricultural group were subdivided into three subgroups on the basis of the magnitude

**Chart 9**

MEDIANS OF TREND-CYCLES OF SUBGROUPS OF NONAGRICULTURAL SERIES, VARYING IN THEIR AMPLITUDES.




of their trend-cycle amplitudes,[15] and the medians of the trend-cycle observations of the series falling in each subgroup were then determined. The same thing was done with the basic nonagricultural group. The medians of the trend-cycle observations of these subgroups are shown in Charts 9 and 10, and are recorded in Appendix A, Table 49.[16] Though

[15] Measures of trend-cycle amplitude are considered in section IV of this chapter.

[16] The groups containing agricultural series were not analyzed in the same way, because the trend-cycle movements of the agricultural series are distinctive; see pp. 207–15. The subgroups of the nonagricultural

the several lines of medians differ markedly in their specific contours, they bear a definite family resemblance, and also conform to the general trend-cycle pattern of the decil charts. Apparently, then, the same sort of trend-cycle rhythm as runs through the industries with small trend-cycle amplitudes runs through the industries with large trend-cycle amplitudes. Though our data support the preceding modified form of the hypothesis of randomness of trend-cycle movements, they do not support the present any more than the hypothesis in its strict general form.

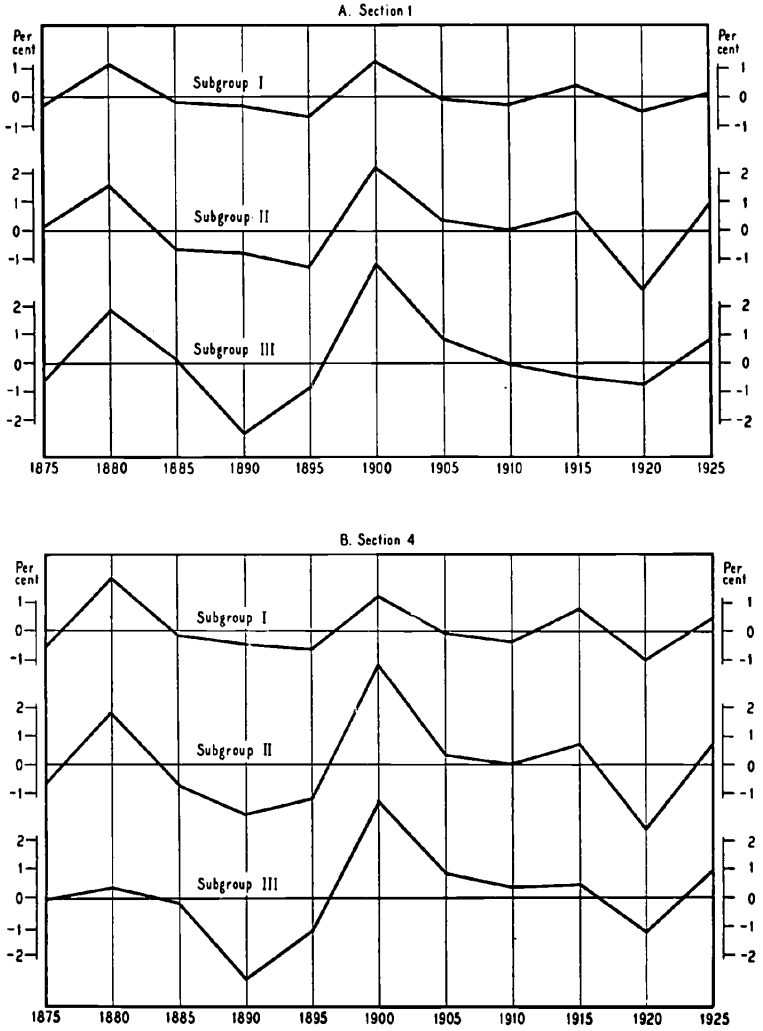
The implications of Charts 9 and 10 go further than the above comments indicate. A common and highly useful method of testing the significance of averages drawn from sample data is to take averages of subsamples. The medians of Charts 9 and 10 are really averages of 'subsamples' of our 'sample' of data; and the fact that the median lines are fairly similar creates a presumption that the larger 'sample' from which they are drawn reflects the true trend-cycle movement of the production universe. There are several differences in

---

group contain 25 series each. Two of the subgroups of the basic nonagricultural series, Section 1, contain 15 series each, and one 16 series. The subgroups of the basic nonagricultural series, Section 4, contain 13 series each. (For certain of the central decade years the number of series is smaller; see p. 181, note. Concerning the distinction between Sections 1 and 4 of basic nonagricultural series, see p. 183, note 10.) The series composing the subgroups of the nonagricultural group are as follows. Subgroup I: 24, 33, 43, 47–8, 50, 52, 58, 64, 66, 69, 72, 77–9, 86–7, 89, 93, 95–7, 101–2, and 104. Subgroup II: 25, 27, 29, 32, 34, 39, 46, 49, 51, 53–4, 56–7, 63, 68, 70–1, 73–4, 80, 82, 85, 88, 90, and 99. Subgroup III: 28, 30–1, 35, 37–8, 40–2, 44–5, 59, 61–2, 65, 67, 75–6, 81, 84, 91–2, 94, 98, and 103. The series composing the subgroups of the basic nonagricultural group, Section 1, are as follows. Subgroup I: 24, 47–8, 50, 52, 58, 64, 79, 83, 86, 95, 97, 101–2, and 104. Subgroup II: 32–4, 39, 43, 49, 55–6, 66, 68, 73, 78, 82, 85, and 93. Subgroup III: 25, 27–9, 31, 36, 46, 59, 62, 71, 74, 80, 90–2, and 99. The series composing the subgroups of the basic nonagricultural group, Section 4, are as follows. Subgroup I: 24, 47–8 50, 52, 64, 66, 79, 83, 86, 97, 101, and 104. Subgroup II: 25, 34, 39, 43, 49, 55–6, 68, 73–4, 78, 82, and 85. Subgroup III: 27–9, 31, 36, 46, 59, 62, 71, 80, 90–1, and 99.

## Chart 10

MEDIANS OF TREND-CYCLES OF SUBGROUPS OF BASIC NONAGRICULTURAL SERIES, VARYING IN THEIR AMPLITUDES



the movements of the median lines; but that is to be expected in the case of small subsamples, since the chances of cancellation of erratic trend-cycle movements are seriously restricted. However, the differences are of some technical importance: they indicate that the method of comparing averages of subsamples is a crude device for extracting the outlines of a pervasive trend-cycle. Decil charts are better adapted for this purpose; for they have the capacity to elicit, even to the point of exaggeration, such harmonies as may exist in cyclical data.[17] When checks on the method are available, decil charts can be trusted to uncover sharply and elegantly the outlines of an underlying cyclical movement.

According to the decil charts of the nonagricultural industries, their general trend-cycle movement between successive central decade years has been as follows: from 1875 to 1880, upward; from 1880 to 1885 and 1885 to 1890, downward; from 1890 to 1895 and 1895 to 1900, upward; from 1900 to 1905 and 1905 to 1910, downward; from 1910 to 1915, upward; from 1915 to 1920, downward; and from 1920 to 1925, upward. These dates are central years of the decades for which average annual rates of growth (decade rates) were computed; and if the decade rates be viewed as measures of the slopes of secular trends of production at quinquennial dates, the above trend-cycle chronology may be regarded as defining roughly the general swing in the percentage rates of industrial growth. If, on the other hand, the decade rates be taken as average rates of change during decade intervals, exceptionally rapid advances in 'general' production are shown to have been experienced during 1875–85, 1895–1905, 1910–20, and 1920–29, and exceptionally mild advances during 1885–95, 1905–15, and 1915–25. The overlap in the closing periods is illuminating of the rapid variations

[17] The method may be used generally in trying to determine the existence of a common rhythm in a mass of cyclical data. It is especially useful in locating the turning points in a general cyclical movement.

Table 31

TYPES OF MOVEMENT OF TREND-CYCLES BETWEEN SUCCESSIVE CENTRAL DECADE YEARS, FOR SEVERAL GROUPS OF PRODUCTION SERIES

| Type of movement | 1875–1880 | 1880–1885 | 1885–1890 | 1890–1895 | 1895–1900 | 1900–1905 | 1905–1910 | 1910–1915 | 1915–1920 | 1920–1925 |
|---|---|---|---|---|---|---|---|---|---|---|
| **'All' series** | | | | | | | | | | |
| Upward ..... | 37 | 17 | 39 | 54 | 75 | 26 | 36 | 53 | 31 | 68 |
| Downward .... | 27 | 48 | 53 | 44 | 23 | 72 | 62 | 44 | 65 | 29 |
| Horizontal .... | ... | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | ... |
| Total ..... | 64 | 67 | 93 | 99 | 99 | 99 | 99 | 99 | 97 | 97 |
| Percentage excess of upward | 15.6 | –46.3 | –15.1 | 10.1 | 52.5 | –46.5 | –26.3 | 9.1 | –35.1 | 40.2 |
| **Nonagricultural series** | | | | | | | | | | |
| Upward ..... | 31 | 8 | 25 | 45 | 59 | 16 | 27 | 40 | 24 | 51 |
| Downward .... | 14 | 38 | 43 | 29 | 15 | 59 | 47 | 34 | 48 | 22 |
| Horizontal .... | ... | 2 | 1 | 1 | 1 | ... | 1 | 1 | 1 | ... |
| Total ..... | 45 | 48 | 69 | 75 | 75 | 75 | 75 | 75 | 73 | 73 |
| Percentage excess of upward | 37.8 | –62.5 | –26.1 | 21.3 | 58.7 | –57.3 | –26.7 | 8.0 | –32.9 | 39.7 |
| **Basic series** | | | | | | | | | | |
| Upward ..... | 23 | 8 | 23 | 32 | 46 | 12 | 24 | 32 | 16 | 44 |
| Downward .... | 17 | 34 | 33 | 27 | 13 | 46 | 35 | 24 | 40 | 13 |
| Horizontal .... | ... | ... | 1 | ... | ... | 1 | ... | 3 | 1 | ... |
| Total ..... | 40 | 42 | 57 | 59 | 59 | 59 | 59 | 59 | 57 | 57 |
| Percentage excess of upward | 15.0 | –61.9 | –17.5 | 8.5 | 55.9 | –57.6 | –18.6 | 13.6 | –42.1 | 54.4 |
| **Basic nonagricultural series** | | | | | | | | | | |
| Upward ..... | 21 | 5 | 16 | 25 | 39 | 9 | 18 | 26 | 12 | 33 |
| Downward .... | 10 | 28 | 27 | 21 | 7 | 37 | 28 | 18 | 31 | 11 |
| Horizontal .... | ... | ... | 1 | ... | ... | ... | ... | 2 | 1 | ... |
| Total ..... | 31 | 33 | 44 | 46 | 46 | 46 | 46 | 46 | 44 | 44 |
| Percentage excess of upward | 35.5 | –69.7 | –25.0 | 8.7 | 69.6 | –60.9 | –21.7 | 17.4 | –43.2 | 50.0 |

in the rate of general industrial growth; but it also indicates that our 'decade rates' fit the actual trend-cycle swing of the American economy less well after 1900 than before. The pattern of the trend-cycles of production here described will be frequently referred to in the following pages as the 'standard' trend-cycle pattern.

If the 'standard' trend-cycle movement from the central decade years 1875 to 1880 was upward and from 1880 to 1885 downward, and so on, it is worth asking to what extent the upward or downward movement of the individual series was general between successive central decade years. Such information will check and supplement the evidence already presented about a general trend-cycle rhythm in American industry. Table 31 furnishes the answer for each of the groups of series whose trend-cycles have been analyzed by the decil technique.[18] The entries in the table designated as 'percentage excess of upward' are the significant figures and were determined as follows: the number of series having a downward trend-cycle movement between one central decade year and the next was subtracted from the number of series having an upward trend-cycle movement, and this difference was expressed as a percentage of the total number of series. The theoretical range of the percentages is from −100 to +100; the percentages indicate by their signs the dominant type of direction of the ensemble of series, and by their magnitudes the degree of dominance. It will be noticed that the percentages confirm the earlier description of the contours of the 'standard' trend-cycle pattern, and that they also confirm the differences among the various groups of series which were noted in the course of the decil analysis of the trend-cycle homogeneity of the series.[19]

[18] For the composition of the groups, see pp. 180–1, note 8.

[19] Taking the 'percentage excess' figures and averaging them, without regard to signs, we get 29.7 per cent for the 'all' series group, 34.5 per cent for the basic group, 37.1 per cent for the nonagricultural group, and

Production indexes may be used in a final check of the conclusions reached on the basis of our production series.[20] It is to be expected that the trend-cycles of indexes of production of nonagricultural groups of industries will confirm the trend-cycle pattern of Charts 6 and 8; that the trend-cycles of the separate indexes for agriculture and for nonagricultural groups will corroborate the suggestion of the decil lines in Charts 5–8 that the trend-cycle movements of agricultural and nonagricultural industries are disparate; and that the trend-cycles of indexes of total production will corroborate the evidence of the median lines in Chart 4. But these expectations are somewhat stronger for unweighted

40.2 per cent for the basic nonagricultural group (these are unweighted arithmetic means). These figures indicate the average conformity of the direction of the trend-cycle movements of the individual series in each of the several groups to the direction of the standard trend-cycle.

Taking separate averages for the positive 'percentage excess' figures and for the negative 'percentage excess' figures, we get 25.5 and −33.9 per cent for the 'all' series group, 29.5 and −39.5 per cent for the basic group, 33.1 and −41.1 per cent for the nonagricultural group, and 36.2 and −44.1 per cent for the basic nonagricultural group. It will be noticed that the averages of both the positive and negative 'percentage excess' figures bear the same order in the several groups as the averages that disregard signs. It will be noticed further that the averages of negative figures are in each group larger than the averages of positive figures; the indications are, then, that there has been somewhat greater consistency of movement among the individual series during downward trend-cycle swings than during upward swings.

Some of the percentages recorded in Table 31 are quite low; this indicates that the degree of regularity in the direction of the trend-cycle movements of the individual series has been low in some cases. Table 31 enables us to enter a caveat to this effect, while the preceding techniques did not. But the percentages in this table may prove quite misleading when taken at their face value, because they do not take account of the degree of trend-cycle movement of the series. The changes in the trend-cycle values from one central decade year to the next of the conforming series (with respect to the standard trend-cycle pattern) are, on the whole, more decisive than those of the non-conforming series.

[20] Concerning the meaning of production indexes, see Ch. VI, sec. I. It need now be noted merely that, although production indexes are of restricted coverage, series of partial coverage often suffice to delineate the form of the trend-cycle pattern, even when they are strongly deficient from the standpoint of a study of primary trends.

than for weighted production indexes. A production index which is deliberately weighted might expose a trend-cycle pattern altogether different from that of a decil chart based on the same series, if the trend-cycles of leading industries characteristically moved at random while the trend-cycles of minor industries moved in concert. Such a possibility is as remote as certain others earlier posited; but only if weighted production indexes trace out a trend-cycle pattern differing from that of the decil charts can production indexes be expected to add new knowledge and reopen our inquiry.

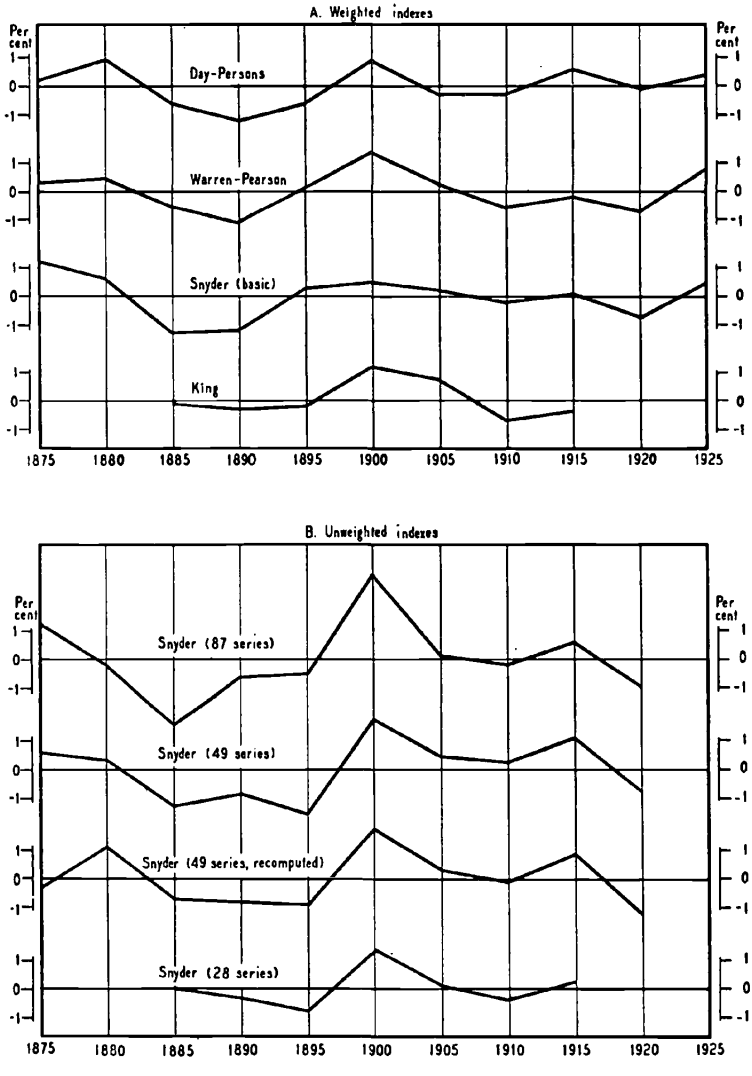
The trend-cycles of several indexes of 'total' production are plotted in Chart 11, and the corresponding figures are given in Appendix A, Table 50.[21] The indexes in the upper portion of the chart are weighted in form, King's index being cruder than the others. The trend-cycles of the Day-Persons and Warren-Pearson indexes harmonize almost perfectly with the median lines of Chart 4. The trend-cycles of King's index show also the same general pattern as the median lines. Snyder's index shows a significant departure from our trend-cycle charts between the central decade years 1875 to 1880; but this is due to the disproportionately large weight assigned to crops in this index.[22] On the whole, then,

21 Snyder's '49 series' and '87 series' indexes are given in his *Business Cycles,* cited above, p. 239; the data for recent years through 1928 have been furnished by Mr. Snyder. The figures of Snyder's '28 series' index, running from 1880 through 1919, have also been furnished by Mr. Snyder. These several indexes are described by Mr. Snyder as relating to 'general production'. For the figures of King's index, which covers 1880–1919, see his "Is Production Keeping Pace with Population?" (Bankers Statistics Corporation, *Weekly Service,* August 24, 1920); this index is described by Dr. King as relating to 'total production'. For the figures of Snyder's index of 'basic' production, see Warren and Pearson, *The Physical Volume of Production,* cited above, p. 64; this index is described by Mr. Snyder as relating to the production of 'leading basic commodities'. For the sources and the presumptive reference area of the remaining indexes of 'total' production, see pp. 262–4, note 11.

22 The percentage 'contributions' of crops to the several indexes of

## Chart 11.

### TREND-CYCLES OF INDEXES OF TOTAL PRODUCTION



the several weighted indexes of 'total' production evidence trend-cycle movements which confirm the rhythm extracted from our individual production series. The indexes in the lower portion of Chart 11 are Snyder's constructions, each of them being unweighted. Curiously enough, these indexes show little conformity prior to the central decade year 1895, and therefore confirm the standard trend-cycle pattern in part only. It is probable, however, that the various departures of Snyder's indexes from the standard pattern arise from certain peculiarities of their composition rather than from their unweighted character. Some of these peculiarities are taken account of in the curve headed 'Snyder (49 series, recomputed)'.[23] This recomputation involves only minor emendations in the '49 series' index; but it alters the complexion of the index considerably and, interestingly enough, brings it into close harmony with the medians of the trend-cycles of our series. Recomputations have not been made of the '28

---

'total' production are as follows:

| Year | Snyder | Warren-Pearson | Day-Persons |
|---|---|---|---|
| 1869 | 89.9 | 72.2 | 55.8 |
| 1879 | 89.5 | 73.9 | 56.3 |
| 1889 | 81.8 | 62.9 | 47.6 |
| 1899 | 74.4 | 57.7 | 43.4 |
| 1909 | 62.3 | 49.9 | 36.8 |
| 1919 | 58.2 | 49.0 | 32.6 |
| 1929 | 50.0 | 39.0 | 25.2 |

[23] The recomputation (data of the component series were furnished by Mr. Snyder) of the '49 series' index involved the following changes. First, the series 'New York canals traffic' and 'quicksilver' were dropped, since they exercise an influence on the index altogether out of proportion to their importance (see p. 260). Second, the 'revised' estimates of the Department of Agriculture for eight crops (listed below) were substituted for the 'original' estimates which apparently had been used by Snyder. (Reference is made here to the revisions effected in 1918, which covered the years 1879 and 1889–1909; see *Yearbook of Agriculture*, 1918, p. 452.) This makes a considerable difference, as may be gathered from the average annual percentage rates of growth during 1890–1900 shown by the original estimates (stated in parentheses) and by the revised estimates for eight

series' and '87 series' indexes,[24] since they are constructed on much the same plan as the '49 series' index.

The trend-cycles of the indexes of production of several major industrial groups are shown in Chart 12, and the corresponding figures are given in Appendix A. Table 50.[25] The five indexes in the upper portion of the chart relate to nonagricultural industries—three cover mining, one manufactures, and one 'industrial activity'. Each of these indexes

---

crops: rye (–1.7) 1.0; barley (–2.2) 2.7; hay (–0.8) 2.0; oats (2.6) 3.3; corn (2.8) 4.8; potatoes (1.6) 3.1; buckwheat (–1.1) 0.7; and wheat (1.9) 4.1. (The rates based on the revised estimates are in most instances different from those presented in Appendix A, Table 45. The reason is that the present rates refer to the exact calendar period 1890–1900, while the rates in the Appendix table are corrected for the cyclical factor. Further, the figure for wheat given here is based on estimates of the Department of Agriculture, while the figure in Table 45 is based on the estimates of the Food Research Institute.)

[24] A few words are pertinent with respect to a conspicuous oddity of Snyder's '87 series' index—its extreme trough at the central decade year 1885. This is easily explained: the index is an arithmetic mean of relatives on a 1910–14 base, is composed of 49 series in the decade of the 'seventies, and of an increasing number of series in later years. Beginning with the 'eighties, a fairly large number of series are included for industries which in the early years were small in size, but subsequently grew at a rapid rate: in 1880, coke, cement, salt, and roofing slate are incorporated for the first time; in 1885, asphalt, barytes, mica, gypsum, and fluorspar; in 1888, oleomargarine. Most of the newly incorporated series have very low relatives during the 1880's, and this tends to pull down the level of the index in these years—so much so, that the index registers an annual rate of decline of 0.1 per cent during the decade 1880–90. Another point of interest concerning the '87 series' index is that, unlike the '49 series' index, it does not show a trough in the decade centered at 1895; this is due to the fact that nonagricultural series play a much more important rôle in the '87 series' index than in the '49 series' index.

[25] Figures of the Cleveland Trust Company index of 'industrial activity' (presented graphically in the company's *Business Bulletin*, May 15, 1931) have been furnished by Mr. Bradford B. Smith, who states that the general scope of the index, though not its specific coverage, is similar to that of the Federal Reserve Board index of industrial production. Figures of Snyder's 'B' index of crops are given in Warren and Pearson, *The Physical Volume of Production*, cited above, p. 64; this index is described by Mr. Snyder as relating to the production of 'products of the soil (leading crops)'. For the sources and the presumptive reference area of the other indexes of major industrial groups, see pp. 252–4, note 11.

traces out a trend-cycle path very similar to that of the standard pattern. The five indexes in the lower portion of the chart relate to crop production: these indexes resemble one another closely, although Snyder's two indexes show individuality at a few points.[26] What is most significant is that the crop indexes evidence a trend-cycle swing of an altogether different cast than the decil charts or the several indexes of nonagricultural production. Chart 12 suggests more forcefully than the preceding analysis of different groups of series that agricultural commodities have not been subject to the same trend-cycle influences as nonagricultural commodities. In view of the peculiar trend-cycle path of the crop indexes, it is now quite clear why the decil charts of the groups including agricultural series are less regular than the decil charts of the groups excluding agricultural series.

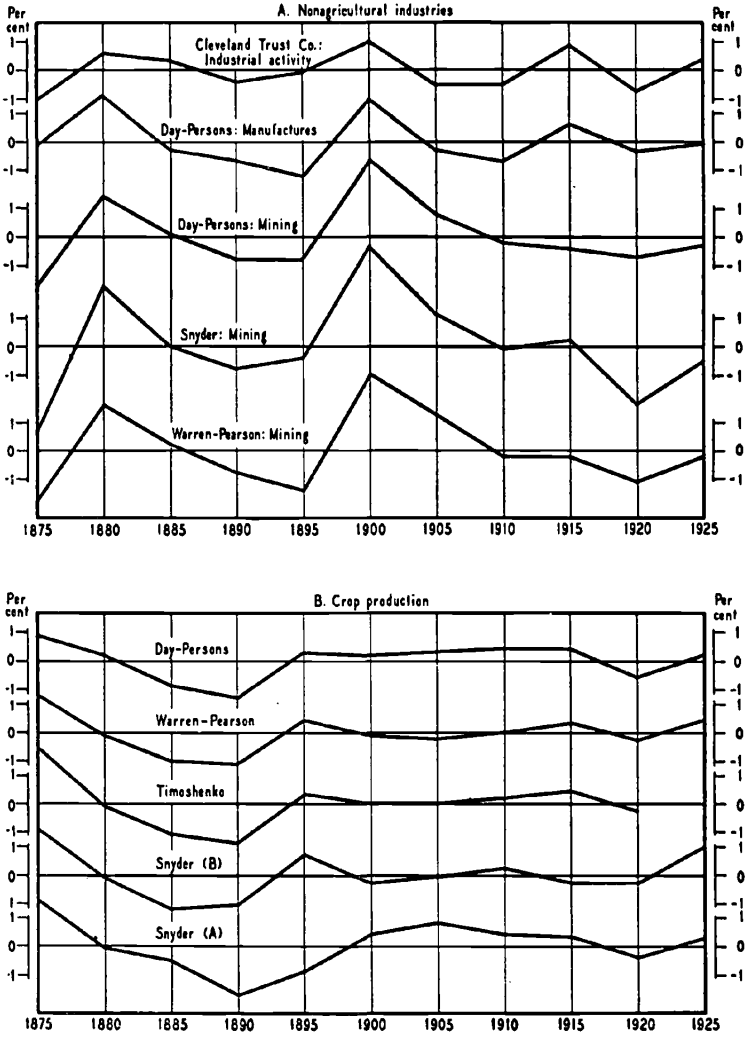
Thus, several lines of evidence—averages of trend-cycles, decil charts, averages for subgroups, summaries of direction of trend-cycle movements, and production indexes—lead independently to the conclusion that there has been a general trend-cycle in the production of the nonagricultural industries of this country during the period since the Civil War.[27] The most powerful of the instruments which we have used in an attempt to uncover and test the validity of a general

[26] In the case of index 'A', this is probably due to the use of the 'original' crop estimates; see pp. 202-3, note 23. As for index 'B', it differs from the other indexes of 'crop' production in excluding hay; also, it includes wool production, and the production of artificial silk.

[27] Though the present investigation of production trends is restricted to the period since 1870, it seemed desirable to determine whether or not there was a general trend-cycle in production during the earlier years. Unfortunately, statistical data on production prior to 1870 are very meagre. And there are other and (in a sense) more fundamental difficulties: the farther back we go, the greater is the importance of agriculture, and the looser the links between nonagricultural industries. An analysis of the trend-cycles of the few (more or less) important series which go back of 1870 (lead, copper, zinc, pig iron, petroleum, rails, vessels, total coal, railway ton-miles, and cotton consumption) disclosed only a mild degree of trend-cycle consistency. The results of the study hardly warrant particularization.

## Chart 12

TREND-CYCLES OF INDEXES OF PRODUCTION
OF SEVERAL MAJOR INDUSTRIAL GROUPS



trend-cycle are the decil charts and averages for subgroups; but the other techniques have provided valuable checks, even though it be true that, if used exclusively, they could furnish only very inconclusive evidence concerning a general trend-cycle. All of our techniques have proceeded by devices of anonymity; this was practically necessary in order to avoid getting lost in the maze of idiosyncratic movements of various of the series. But now that analysis has built up a strong presumption that there has been a pervasive trend-cycle in American industry, it is desirable to restore to the various series their individuality, and examine their specific trend-cycles in relation to the standard trend-cycle pattern.

## III. TREND-CYCLE PATTERNS OF INDIVIDUAL INDUSTRIES

A detailed analysis of the trend-cycle movements of the individual production series would round out the analysis and endow it with realistic flavor; but as this task is too formidable to be undertaken here, a cursory examination will have to suffice. The present section is devoted to a survey of the patterns of the trend-cycles of the individual series, the next to their amplitudes. The analysis of the patterns is a continuation of the preceding inquiry into a general trend-cycle. The analysis of the amplitudes supplements that of the patterns, the two yielding a general description of trend-cycles in individual industries.

A basing rod for the measurement of the trend-cycle patterns of the individual production series is furnished by the standard trend-cycle. The series will be compared with the standard trend-cycle pattern by means of an index of trend-cycle conformity computed for each series in the following manner: the trend-cycle movement between two successive central decade years is given a score of $+1$, $-1$, or 0, according as the movement conforms to the direction of

the standard trend-cycle, is opposite to it, or is merely horizontal; the scores are then combined by taking the excess of pluses over minuses, and expressing the difference as a ratio to the total number of scores. The index of conformity may vary between the limits +1 and −1, the former denoting maximum direct conformity to the standard trend-cycle pattern, and the latter maximum inverse conformity. Though it is convenient to compare the series through their indexes of trend-cycle conformity, the comparisons may be very inexact for individual series taken by themselves; and it is therefore best to pay chief attention to the general level of the indexes in various industrial groups.[28]

### 1. Agricultural Industries

In inquiring about the existence of a pervasive trend-cycle in production, we encountered several indications that agricultural industries have not followed the characteristic pattern which seems to run through the trend-cycle movements of nonagricultural industries. The agricultural industries provide the outstanding group of exceptions to a really general trend-cycle movement in production. It is therefore desirable to examine the trend-cycles of the agricultural series apart from the nonagricultural.

A fairly definite story about trend-cycles in agricultural production is disclosed by Tables 32–34 and Chart 13. The chart shows clearly that the leading crops trace out trend-cycle patterns of strong individuality, and that few have more than a faint resemblance to the standard trend-cycle

[28] Several factors make for error in the indexes: the original data are not always accurate, the method of determining the decade rates lacks absolute nicety, the exponential curves fitted to the decade rates give poor fits in a few cases, and only the direction of the trend-cycle movement is considered in the measures of conformity. Also, the comparability of the indexes of conformity for the various series is impaired somewhat by the fact of their being based on such variable periods as the series cover. See Appendix C, III.

pattern. It will be seen from Table 32 that the average level of the indexes of trend-cycle conformity of the agricul-

Table 32

CONFORMITY OF TREND-CYCLES OF PRODUCTION SERIES TO STANDARD TREND-CYCLE: AGRICULTURE AND FISHERIES

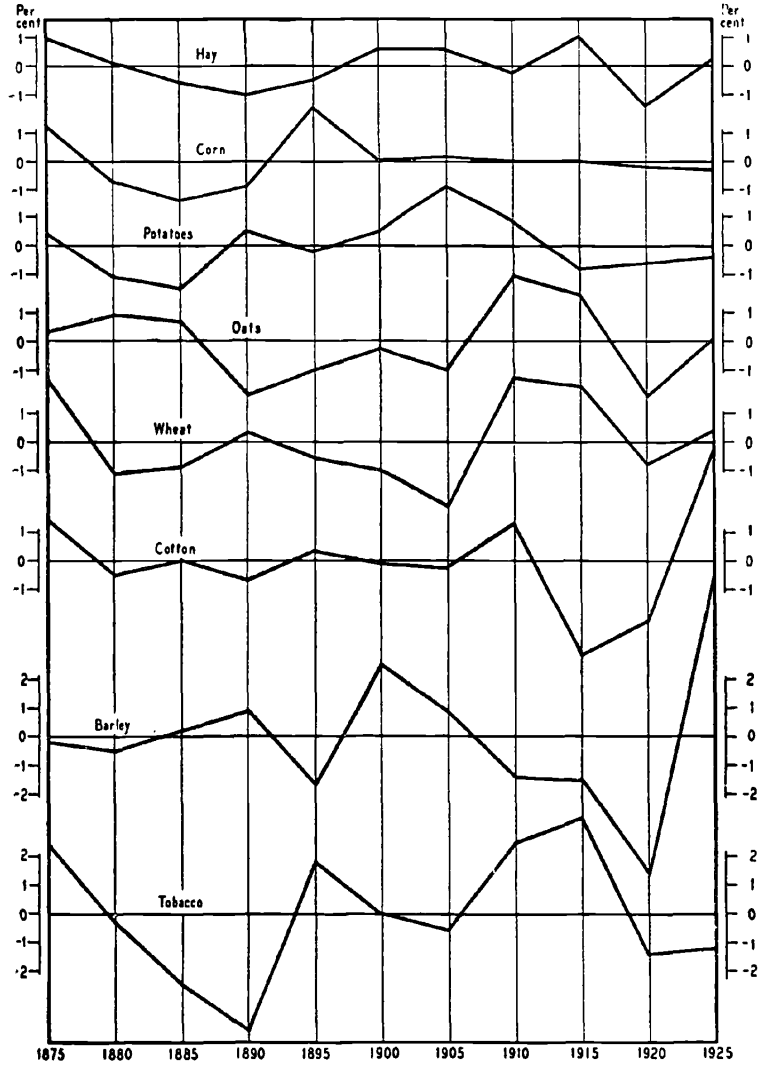
| Series | Period covered by series | Index of conformity |
|---|---|---|
| Cattle | 1880–1929 | .75 |
| Hay | 1870–1930 | .70 |
| Oats | 1870–1930 | .60 |
| Rice | 1870–1929 | .60 |
| Fish, total | 1880–1929 | .50 |
| Flaxseed | 1879–1929 | .50 |
| Hogs | 1880–1929 | .50 |
| Tobacco, raw | 1870–1929 | .40 |
| Beet sugar | 1870–1929 | .20 |
| Cod and mackerel | 1870–1929 | .20 |
| Whale | 1870–1929 | .20 |
| Wool | 1870–1929 | .20 |
| Barley | 1870–1929 | .00 |
| Molasses and sirup | 1870–1929 | .00 |
| Raisins | 1872–1929 | .00 |
| Corn | 1870–1929 | −.10 |
| Cane sugar | 1870–1929 | −.20 |
| Cotton | 1870–1929 | −.20 |
| Potatoes | 1870–1929 | −.20 |
| Rye | 1870–1929 | −.20 |
| Wheat | 1870–1930 | −.40 |
| Sheep | 1880–1929 | −.50 |
| Buckwheat | 1870–1929 | −.60 |

tural and fisheries series is quite low. Table 33 shows that the conformity of the crop series to the trend-cycle in total crop production [29] is no greater than their conformity to the

[29] The form of the trend-cycle pattern in total crop production was assumed to be that of the Day-Persons, Warren-Pearson, and Timoshenko crop indexes, which agree substantially in their trend-cycle movements, despite certain differences in their construction and coverage. The trend-

## Chart 13

TREND-CYCLES OF PRODUCTION OF EIGHT LEADING CROPS



standard trend cycle. It might have been expected that trend-cycles in acreage [30] would conform more closely to the stand-

Table 33

CONFORMITY OF TREND-CYCLES OF CROP SERIES TO TREND-CYCLE IN TOTAL CROP PRODUCTION AND TO STANDARD TREND-CYCLE

| Series | Period covered by series | Conformity to trend-cycle in total crop production | Conformity to standard trend-cycle |
|---|---|---|---|
| Tobacco, raw | 1870–1929 | 1.00 | .40 |
| Hay | 1870–1930 | .50 | .70 |
| Oats | 1870–1930 | .50 | .60 |
| Cotton | 1870–1929 | .50 | −.20 |
| Rice | 1870–1929 | .25 | .60 |
| Raisins | 1872–1929 | .25 | .00 |
| Corn | 1870–1929 | .25 | −.10 |
| Wheat | 1870–1930 | .25 | −.40 |
| Flaxseed | 1879–1929 | .00 | .50 |
| Rye | 1870–1929 | .00 | −.20 |
| Barley | 1870–1929 | −.25 | .00 |
| Potatoes | 1870–1929 | −.25 | −.20 |
| Buckwheat | 1870–1929 | −.25 | −.60 |
| Beet sugar | 1870–1929 | −.50 | .20 |
| Cane sugar | 1870–1929 | −.50 | −.20 |
| Molasses and sirup | 1870–1929 | −.75 | .00 |

ard trend-cycle than do the trend-cycles of crop output; but the indexes of trend-cycle conformity of crop acreages, pre-

cycle movement in total crop production between central decade years was taken to be as follows: from 1875 to 1880, downward; 1880 to 1885, downward; 1885 to 1890, downward; 1890 to 1895, upward; 1895 to 1900, downward; 1900 to 1905, horizontal; 1905 to 1910, upward; 1910 to 1915, horizontal; 1915 to 1920, downward; and 1920 to 1925, upward. The conformity of the crop series to the trend-cycle pattern of total crop production was determined in the same way as the conformity to the standard trend-cycle, except that the changes from the central decade years 1900 to 1905, and 1910 to 1915 were disregarded.

[30] The statistics of acreages were taken from the *Yearbook of Agriculture*, except the figures for wheat for 1870–1910, which were obtained from "Wheat Acreage and Production in the United States since 1866" (Food Research Institute, *Wheat Studies*, Vol. II, No. 7, June, 1926). Trend-cycles

sented in Table 34, have much the same general level as the indexes of trend-cycle conformity of the crop production

Table 34

CONFORMITY OF TREND-CYCLES OF ACREAGES AND PRODUCTION VOLUMES OF EIGHT LEADING CROPS TO STANDARD TREND-CYCLE

| Crop | Period covered by series | Index of conformity | |
|---|---|---|---|
| | | Acreage | Production |
| Hay | 1870–1930 | .40 | .70 |
| Barley | 1870–1929 | .20 | .00 |
| Cotton | 1870–1929 | .20 | −.20 |
| Potatoes | 1870–1929 | .20 | −.20 |
| Wheat | 1870–1930 | .20 | −.40 |
| Oats | 1870–1930 | .10 | .60 |
| Tobacco, raw | 1870–1929 | −.20 | .40 |
| Corn | 1870–1929 | −.20 | −.10 |

series.[31] The randomness of trend-cycles in agricultural production cannot, then, be attributed simply to erratic trend-cycles in acre-yields.

of the acreage series were determined in the same way as the trend-cycles of the production series. Data of the trend-cycles of acreages are given in Appendix A, Table 51.

[31] As indexes of trend-cycle conformity are summaries for a rather long period, they may conceal correlated movements during shorter intervals. (1) Thus, indexes of the trend-cycle conformity of the agricultural production series to the standard trend-cycle obscure the fairly uniform downward movement of the series between the central decade years 1915 and 1920, and the fairly uniform upward movement of the series between 1920 and 1925. (2) Similarly, indexes of the trend-cycle conformity of the outputs of the various crops to the trend-cycle of total crop production obscure the close conformity between the central decade years 1875 and 1880, 1915 and 1920, and 1920 and 1925. (3) Once more, indexes of the trend-cycle conformity of crop acreages to the standard trend-cycle obscure the fairly general conformity between the central decade years 1880 and 1885, 1885 and 1890, and 1915 and 1920.

It would seem, then, that during certain periods of intermediate duration, general factors impinging on agriculture may have been more important than, and may have dominated over, the specific factors affecting the

The individual character of the trend-cycles in agriculture arises out of the basic conditions of agricultural production. The use of farm land is influenced in very large part by price movements: the trends in the acreages of crops tend to respond, though to a variable degree, to trends in prices which are normally divergent. The result is little harmony in the secular movements of the acreages of the various crops. The shifts in acreage are made possible by the considerable mobility of agricultural resources—land, equipment, and labor—from one product to another. Speaking broadly, agricultural commodities constitute a single industry—in any event, this is true of the various agricultural regions taken separately. Thus oats, barley, corn, and winter rye compete with spring wheat for acreage; oats and corn with winter wheat; corn, velvet beans, and cow peas with cotton; peanuts and cotton with tobacco; hay with various cash crops; and various crops with pasture. The competitive relations among the various agricultural products tend to make for discrepant trend-cycles in acreage, and therefore, in output.

The technical relations among agricultural products, unlike the competitive relations, conduce generally to similarity in trend-cycles; but this is not true of all technical relations and, in any case, the technical relations are in a sense less important than the competitive. Technical ties in the form of sequences (that is, rigid rotation systems) and complementary schemes of production (for example, hogs and corn) make for similar trend-cycles. But the influence of these technical ties is not diffusive, since they are restricted to distinct groups of crops and distinct areas. Nor are the technical relations among products absolutely rigid: they tend to

---

production of the individual crops. But this has definitely not been the case over a sizable period of economic history. We have spoken above of a trend-cycle in total crop production, but its meaning is merely statistical; there is no general (pervasive) trend-cycle in crop production.

vary, as a matter of fact, with considerations of price advantage. Finally, certain technical relations among crops, especially those realized in response to the operation of the natural elements, tend to make for discrepant trend-cycles. Thus, buckwheat is very commonly resorted to when physical conditions for growing other crops are unfavorable; and a good deal of barley acreage serves to complement the fluctuations in other crops, especially when winter killing affects them. The technical relations in agriculture are not, therefore, of a sort to reduce materially the influence of the competitive relations which make for individual trend-cycles in production.

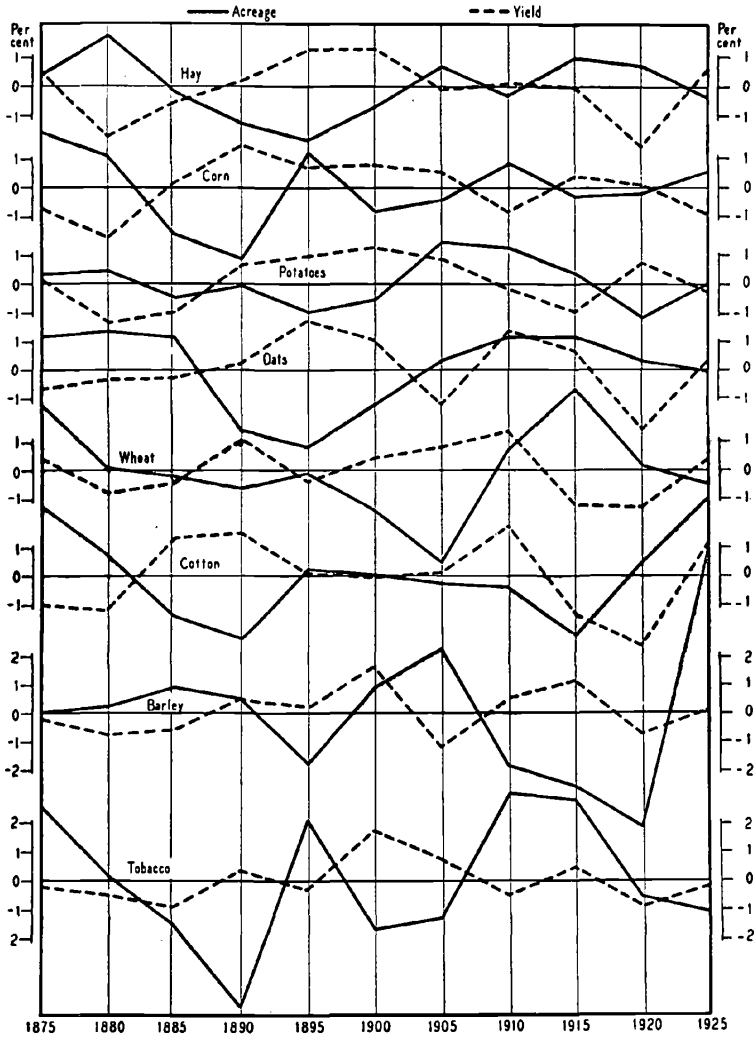
The trend-cycle movement of acre-yields is a contributory cause of individual trend-cycles in agricultural production, but it is apparently a minor cause only. Though natural factors dominate year-by-year changes in acre-yields, it may be expected that their effects will be self-cancelling over a period of ten years or longer, so that the secular trend of acre-yields will tend to bear primarily the impress of the human factor.[32] Chart 14 shows that there is generally an inverse relationship between the trend-cycles of the acreage and acre-yield of the leading crops.[33] This systematic feature of the trend-cycles of acre-yields suggests that agricultural industries have responded to economic stimuli chiefly through modifications in acreage. When for one reason or another

[32] To be sure, natural determinants of yields occasionally dominate over periods as long as a decade or even longer; for example, the influence of the boll weevil on cotton yields in recent years. It is only when natural factors dominate that trend-cycles in acre-yields are truly erratic.

[33] See pp. 210–1, note 30. The decade rates of acre-yields were obtained by dividing the decade rates for production by the corresponding decade rates for acreage, each expressed in ratio form—that is, as 1.054 and not 5.4 per cent, and so on (see F. C. Mills, *The Behavior of Prices,* National Bureau of Economic Research, 1927, pp. 71–2). The trend-cycles of the acre-yields of each crop were then determined in the same way as the trend-cycles of the production series. Data of the trend-cycles of the acre-yields are given in Appendix A, Table 51.

## Chart 14

TREND-CYCLES OF ACREAGES AND ACRE-YIELDS OF EIGHT LEADING CROPS



acreage was expanded at a relatively rapid rate, crop culture was practiced less intensively (or else improvements proceeded at a relatively mild pace), and lands of inferior quality were brought under the plough; so, a rise in the trend-cycle of acreage generally meant a decline in the trend-cycle of yields. On the other hand, when the rate of expansion in acreage slackened, relatively more care was devoted to crop cultivation; and when the trend of acreage actually declined, it was on the whole the poorer lands which were withdrawn from use; so, a decline in the trend-cycle of acreage generally meant a rise in the trend-cycle of yields. It will be seen from Chart 14 that the inverse relationship between trend-cycles in acreage and yield is slightly higher for the early period than for recent decades. This may mean that the agricultural community has come of late to respond to considerations of price advantage by controlling yields in slightly greater degree than formerly; which would be but a natural consequence of the passing of the frontier and the diminution of virgin land.

### 2. Nonagricultural Industries

Except for agriculture, a general trend-cycle rhythm seems to have been pervasive in industrial production. The indexes of trend-cycle conformity of the nonagricultural series are distributed by industrial groups in Tables 35–37. For illustrative purposes, the trend-cycles of a number of nonagricultural series are presented graphically, for several groups of related series, in Charts 15 and 17–19. Chart 16 shows medians of trend-cycles of manufactures from agricultural and from mineral raw materials.

Most of the nonagricultural series have positive indexes of trend-cycle conformity, and the more important of the series are generally found among those having rather high

Table 35

CONFORMITY OF TREND-CYCLES OF PRODUCTION SERIES TO STANDARD TREND-CYCLE: MINING

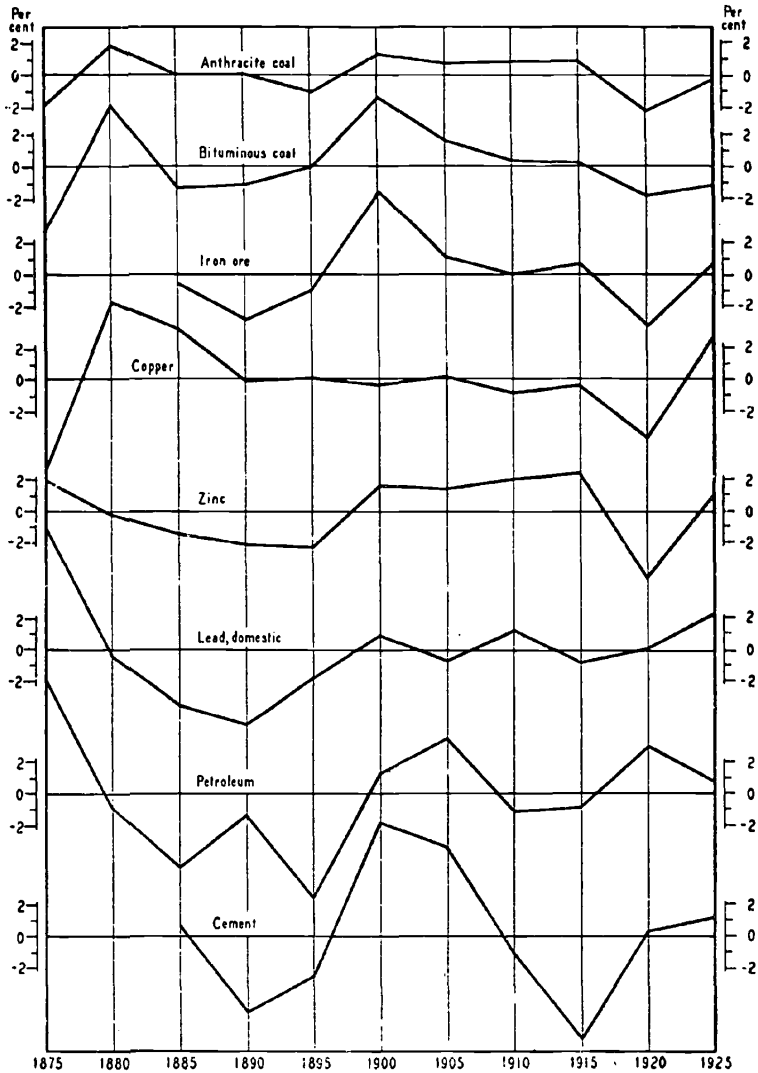
| Series | Period covered by series | Index of conformity |
|---|---|---|
| Iron ore | 1880–1929 | 1.00 |
| Natural gas | 1882–1929 | .75 |
| Pyrites | 1880–1929 | .75 |
| Bituminous coal | 1870–1929 | .60 |
| Coal, total | 1870–1929 | .60 |
| Copper | 1870–1929 | .60 |
| Cement, total | 1880–1929 | .50 |
| Fluorspar | 1880–1929 | .50 |
| Salt | 1880–1929 | .50 |
| Sulphur | 1880–1929 | .50 |
| Anthracite coal | 1870–1929 | .40 |
| Zinc | 1870–1929 | .40 |
| Non-Portland cements | 1880–1929 | .25 |
| Lead, domestic | 1870–1929 | .20 |
| Mercury | 1870–1929 | .10 |
| Gold | 1870–1929 | .00 |
| Phosphate rock | 1870–1929 | .00 |
| Portland cement | 1880–1929 | .00 |
| Petroleum | 1870–1929 | −.20 |
| Silver | 1870–1929 | −.20 |
| Gypsum | 1880–1929 | −.25 |
| Asphalt | 1880–1929 | −.50 |

indexes.[34] In the mineral group, the industrial metals and fuels are conspicuous by their generally high indexes of conformity. Among manufactures, the iron and steel series have the highest indexes; series of transportation equipment, textile products, tobacco products, and nonferrous industrial

[34] The arithmetic mean of the indexes of trend-cycle conformity of Section 1 of the basic nonagricultural series is .40; of Section 4 of the basic nonagricultural series, .49. (For the composition of these groups, see pp. 180–1, note 8, and p. 183, note 10.) The arithmetic mean of the non-basic nonagricultural series (this group consists of 31 series, these being the series above number 23, as listed on p. 163, note 77) is .34.

## Chart 15

TREND-CYCLES OF PRODUCTION OF EIGHT LEADING MINERALS



## Table 36

CONFORMITY OF TREND-CYCLES OF PRODUCTION SERIES TO STANDARD TREND-CYCLE: MANUFACTURES AND CONSTRUCTION

| Series | Period covered by series | Index of conformity |
|---|---|---|
| Cigars | 1880–1929 | 1.00 |
| Coke | 1880–1929 | 1.00 |
| Rolled iron and steel | 1885–1929 | 1.00 |
| Pig iron | 1870–1929 | .80 |
| Superphosphate | 1870–1929 | .80 |
| Tin imports | 1870–1929 | .80 |
| Tin-plate consumption | 1871–1929 | .80 |
| Canned corn | 1885–1929 | .71 |
| Tobacco consumption | 1880–1929 | .62 |
| Cocoa imports | 1870–1929 | .60 |
| Cottonseed cake and meal | 1872–1929 | .60 |
| Lead consumption | 1870–1929 | .60 |
| Minor fiber imports | 1870–1929 | .60 |
| Rail consumption | 1870–1929 | .60 |
| Rails | 1870–1929 | .60 |
| Sisal imports | 1870–1929 | .60 |
| Steel | 1870–1929 | .60 |
| Vessels | 1870–1929 | .60 |
| Distilled spirits | 1870–1918 | .50 |
| Gold consumption | 1880–1929 | .50 |
| Locomotives | 1880–1929 | .50 |
| Nails | 1872–1929 | .50 |
| Silk imports, raw | 1870–1929 | .50 |
| Zinc consumption | 1873–1929 | .44 |
| Copper consumption | 1883–1929 | .43 |
| Silk imports, unmanufactured | 1883–1929 | .43 |
| Cotton consumption | 1870–1929 | .40 |
| Cottonseed oil | 1872–1929 | .40 |
| Jute imports | 1870–1929 | .40 |
| Rubber imports | 1870–1929 | .40 |
| Roofing slate | 1879–1929 | .37 |
| Tobacco and snuff | 1871–1929 | .30 |
| Fermented liquors | 1870–1918 | .25 |
| Coffee imports | 1870–1929 | .20 |
| Manila hemp imports | 1870–1929 | .20 |

Table 36 (cont.)

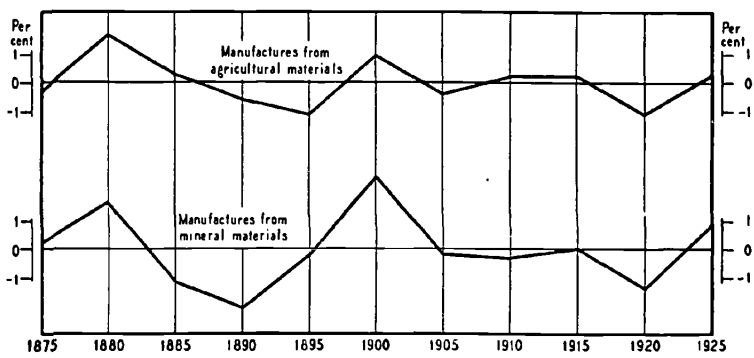
CONFORMITY OF TREND-CYCLES OF PRODUCTION SERIES TO STANDARD TREND-CYCLE: MANUFACTURES AND CONSTRUCTION

| Series | Period covered by series | Index of conformity |
|---|---|---|
| Wool consumption | 1870–1930 | .20 |
| Flaxseed consumption | 1879–1929 | .00 |
| Flour | 1880–1929 | .00 |
| Silver consumption | 1880–1929 | .00 |
| Building permits | 1874–1929 | −.11 |
| Aluminum | 1883–1929 | −.14 |
| Canned tomatoes | 1885–1929 | −.14 |
| White lead | 1884–1929 | −.14 |
| Antimonial lead | 1871–1929 | −.20 |
| Lead, total | 1870–1929 | −.20 |
| Raw sugar consumption | 1870–1930 | −.20 |
| Cigarettes | 1880–1929 | −.25 |

metals and their derivatives have, speaking generally, fairly high indexes; and manufactures from mineral materials have, on the average, somewhat higher indexes of conformity

Chart 16

MEDIANS OF TREND-CYCLES OF TWO GROUPS OF MANUFACTURES



than manufactures from agricultural materials. The several railway series, shares traded, and deflated clearings have the highest indexes in the transportation and trade division. On the other hand, little direct conformity to the standard trend-cycle pattern is evidenced by the precious metals, many of the series relating to construction, a number of food products, and the series on foreign trade.

Table 37

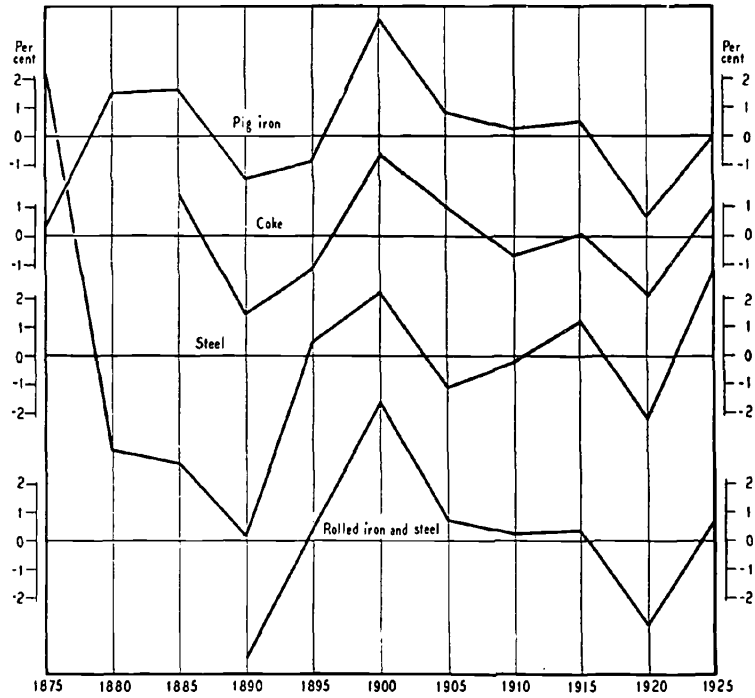
CONFORMITY OF TREND-CYCLES OF PRODUCTION SERIES TO STANDARD TREND-CYCLE: TRANSPORTATION AND TRADE

| Series | Period covered by series | Index of conformity |
|---|---|---|
| Railway freight | 1882–1929 | 1.00 |
| Shares traded | 1875–1929 | 1.00 |
| Deflated clearings | 1870–1929 | .80 |
| Railway ton-miles | 1870–1929 | .80 |
| Railway passenger-miles | 1882–1929 | .50 |
| S. S. Marie canals traffic | 1870–1929 | .50 |
| N. Y. canals traffic | 1870–1929 | .40 |
| Postal money orders | 1870–1929 | .20 |
| Postage stamps | 1870–1929 | .00 |
| Agricultural exports | 1870–1929 | −.20 |
| Coastal trade | 1870–1929 | −.20 |
| Tonnage entered and cleared | 1870–1929 | −.20 |

Certain of the nonagricultural series have been insensitive to the standard trend-cycle rhythm throughout most of the period covered (in the sense that they have not conformed consistently for any considerable continuous period). Many and varied causes account for their non-conformity, but the chief forces at work may be subsumed under three categories. (1) Over a large range of industry, conditions of joint production obtain; and when considerable quantities of the output of a given commodity are a by-product of activities carried on principally for some other product or products, the given commodity may depart considerably, as do silver

Chart 17

TREND-CYCLES OF PRODUCTION OF IRON, STEEL, AND COKE

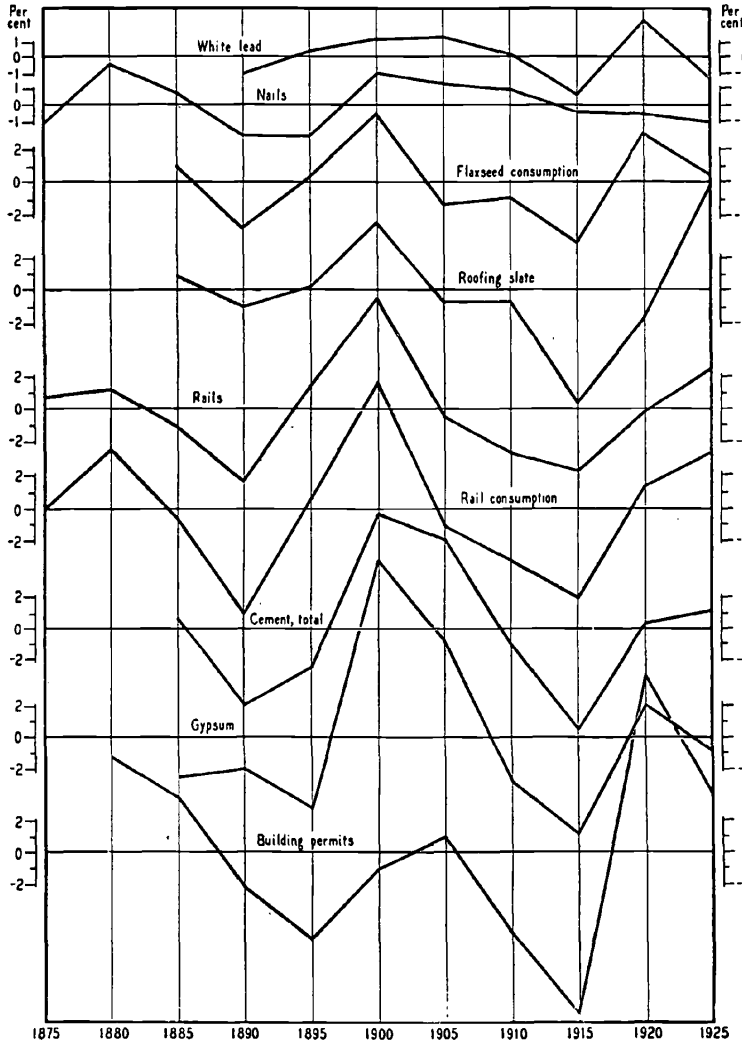



and lead,[35] from the general rhythm of the secular trends of industry. (2) Competitive relations among commodities are most important when the output of a number of commodities constitutes a composite supply for the satisfaction of a given want or limited range of wants: natural cement and

[35] For a time in the latter part of the nineteenth century, lead was in large part a by-product of silver mining. At present, the bulk of American silver production (in 1928, about 80 per cent) is a by-product of ores mined primarily for some other metal; see C. W. Merrill, *Economic Relations of Silver to Other Metals in Argentiferous Ores* (Bureau of Mines, Economic Paper 10).

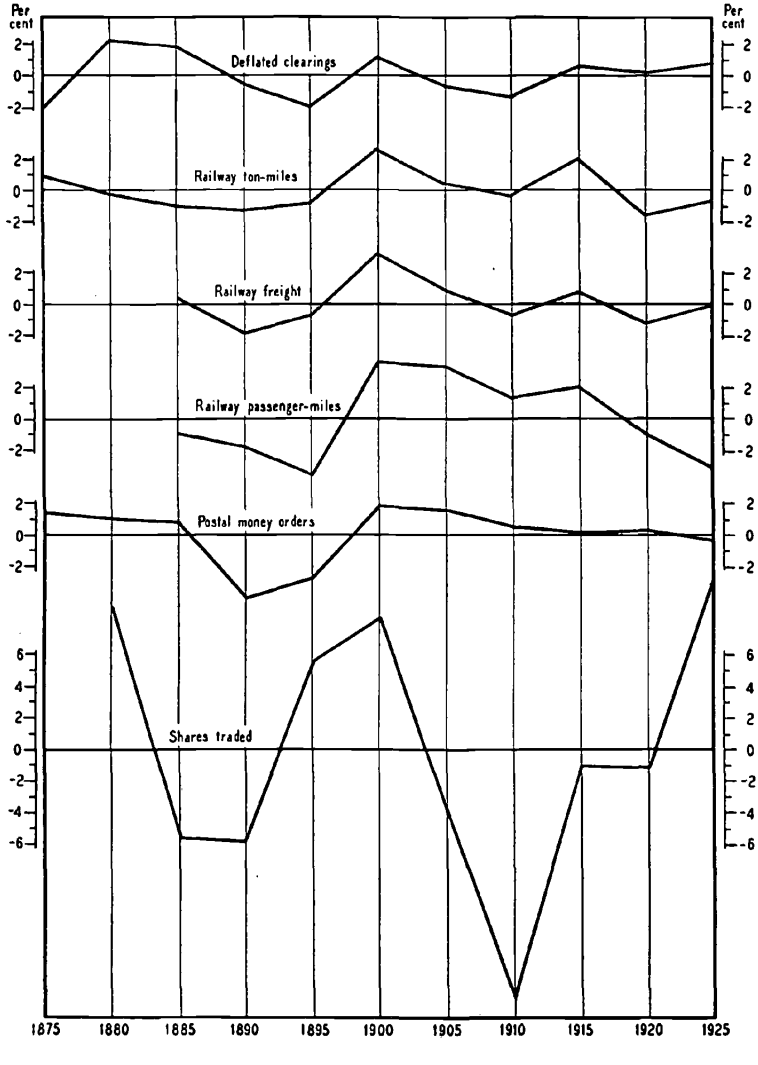
## Chart 18

TREND-CYCLES OF PRODUCTION SERIES
RELATING TO CONSTRUCTION



## Chart 19

TREND-CYCLES OF SEVERAL SERIES RELATING TO TRANSPORTATION AND TRADE



Portland cement, native asphalt and manufactured asphalt, white lead and zinc oxide, wool and other textiles, and so on, have been rivals in such a sense. Taken separately, such industries are 'incomplete'; and when one gains rapidly at the expense of the other, the trend-cycles [36] of one or both are likely to depart from the standard pattern. (3) Special factors have dominated the trend-cycles of certain industries. An outstanding instance is gold production, whose secular trend has been influenced in large part by the cost of gold extraction, which has tended to vary with the trend of commodity prices.[37] Another is the flour industry whose trend-cycle pattern has followed closely that of wheat production. In the case of petroleum, the defective organization of the industry from the standpoint of its technical basis has conduced to erratic trend-cycles: the petroleum industry is strongly competitive and subject to the mining law that property rights in land surfaces descend vertically,—but oil underground is migratory and no respecter of business organization; the consequence has been that new discoveries of petroleum beds have been exploited irrespective of the general state of the industry and that drilling has taken place near the boundary lines of individual leaseholds, only to be followed by 'offset' wells drilled on adjoining lands. Then again, the trend-cycles of the series 'tonnage entered and cleared' and 'agricultural exports' have been influenced in

[36] The series 'Portland cement' has a low index of trend-cycle conformity, and so has the series 'non-Portland cements'; the series 'total cement', however, has a rather high index. The 'asphalt' series used in this study covers the native product only, but native asphalt has been eclipsed in recent decades by the asphalt manufactured from domestic and Mexican petroleum; as the statistical record of manufactured asphalt is incomplete, exact computations are not worth making, but the indications are that an index of conformity of total asphalt production would be higher than that of native asphalt alone. Wool consumption has a low index of trend-cycle conformity; but the numerical indications are that an index of production of all textile products would show high conformity.

[37] The trend-cycles of gold production appear to have varied inversely with the trend of *actual* commodity prices.

considerable part by trend-cycles in the output of the domestic agriculture, which, as we have seen, bear little relation to the standard trend-cycle.

In addition to those nonagricultural series which have been insensitive to the standard trend-cycle during most of the period since 1870, there are some series which have been sensitive at one end of the period but not at the other, and for only this reason have low indexes of trend-cycle conformity. And although most of the series conform rather well to the standard pattern during the period taken as a whole, all but six of the series fail to conform during one or another portion of the period. All kinds of special factors account for the numerous departures of the series from the standard pattern during certain periods; but the most obtrusive are those associated with fundamental changes in the position of given industries in the economic system. Thus, the non-conformity of railway ton-miles to the standard pattern between the central decade years 1875 and 1880 is due partly to the relatively large importance of agricultural freight at that early time.[38] It is only in the last decade that the series of railway passenger-miles has conspicuously failed to conform to the standard trend-cycle; and its recent erratic behavior is doubtless traceable to the appreciable replacement of the railway by the automobile as an agency for the transport of passengers: the volume of railway passenger traffic reached an absolute peak in 1920 and by 1929 it had declined almost 35 per cent from its high point. Sulphur production shows perfect conformity to the standard trend-cycle since 1900;[39] prior to that date, it shows little conformity, but the industry was of negligible size before the turn of the century. Nail production shows perfect conform-

[38] See Appendix C, III.

[39] This is shown by calculations restricted to the period since 1900, but not by the trend-cycle data for sulphur given in Appendix A, Table 47. The latter, however, are of little significance; see p. 103, note 8.

ity during most of the period covered, but of late its movement has diverged from that of the standard pattern and also from that of the other series of 'construction' materials; this probably reflects the sharp curtailment in the use of wood for building and packing. Then again, the series of postal money orders shows fairly close conformity during the early decades; but in recent decades, probably as a result of the growing practice of keeping checking accounts, its movement has been insensitive to the general trend-cycle. Apart from those industries whose position in the economic system has undergone a fundamental change, the construction series provide the most conspicuous instances of non-conformity to the standard pattern during certain periods. Beginning with the central decade year 1910, the construction series (see Chart 18) have diverged more or less uniformly—a result in considerable part of the authoritarian restrictions on construction during the War period.

## IV. TREND-CYCLE AMPLITUDES OF INDIVIDUAL INDUSTRIES

The measures of inconstancy in the rates of growth of individual industries have already suggested that the magnitude of the swings in trend-cycles is considerable and varies from series to series.[40] Now that the statistical analysis of the trend-cycle patterns has been concluded, we may strive for exact notions concerning their amplitudes. A measure of the trend-cycle amplitude of a series may be obtained by taking the standard deviation of its trend-cycle observations; the latter, it will be recalled, are deviations of the decade rates of a series from an exponential curve fitted to the rates. The standard deviation of the trend-cycle observations of a series states the degree of variation in the slope of the secular trend of the series with reference to the slope of a primary

[40] See Ch. III, sec. II.

trend that is in effect a 'logarithmic' parabola.[41]

The measures of trend-cycle amplitude are summarized analytically[42] in Table 38 and are recorded by individual series in Table 39. The first table shows that agricultural series account largely for the lowest of the amplitudes, and mineral series for the highest; and that within each industrial division, non-basic series account mainly for the extremely high amplitudes. The average level of the amplitudes is relatively low in the division of agriculture and fisheries, and of transportation and trade; and relatively high in the division of mining, and of manufactures and construction. Chart 16 indicates that the trend-cycles of manufactures from agricultural materials are of smaller amplitude than of manufactures from mineral materials.[43] The most obtrusive in-

[41] See Ch. IV, sec. I, and this chapter, sec. I. The standard deviation of the decade rates of a series (see Ch. III, sec. II) measures the influence of two factors: the drift of the decade rates and the amplitude of the fluctuations of the decade rates about a line defining their general drift. The influence of the first factor is eliminated largely in the measure of trend-cycle amplitude. This has two consequences. First, the measures of trend-cycle amplitude are lower than the standard deviations of decade rates in all series except the following, in which the two are identical: 13, 21, 23, 31, 40, 74, 91, and 102. Second, the variation of the measures of trend-cycle amplitude is lower than that of the standard deviations of decade rates. The correlation between the two measures is high; the coefficient of correlation for the 'all' series group is .95 (the coefficient for this group becomes .91, when the five series having the largest values—series 2, 35, 44, 65, and 84—are dropped).

[42] For the composition of the 'all' series and basic series groups, see Appendix A, Table 46, columns *e* and *f*.

[43] The medians of the trend-cycle observations of the two groups are given in Appendix A, Table 52. The manufactures from agricultural materials include the following series: 46–51, 54, 58, 61, 66, 69–71, 74, 76–7, 79, 86, and 88–9; for the central decade years 1875, 1880, and 1885, series 60 is substituted for series 86. The manufactures from mineral materials include the following series: 52–3, 56–7, 62–4, 67–8, 72–3, 75, 78, 80–2, 84–5, 87, and 90. (For certain of the central decade years, not all of these series are included; see pp. 180–1, note 8.)

The amplitude of the medians of the trend-cycles of manufactures from agricultural materials is 0.8 per cent, of the medians of the trend-cycles of manufactures from mineral materials 1.3 per cent. As for the individual series, 8 manufactures from mineral materials have trend-cycle amplitudes

## Table 38

### FREQUENCY DISTRIBUTIONS OF MEASURES OF TREND-CYCLE AMPLITUDE, FOR 'ALL' SERIES AND BASIC SERIES, BY INDUSTRIAL GROUPS

| Measure of trend-cycle amplitude (per cent) | Agriculture and fisheries | Mining | Manufactures and construction | Transportation and trade | All industries |
|---|---|---|---|---|---|
| | | | 'All' series | | |
| 0.0 to 0.9 | 4 | .. | 1 | 1 | 6 |
| 1.0 to 1.9 | 9 | 4 | 16 | 6 | 35 |
| 2.0 to 2.9 | 4 | 4 | 13 | 2 | 23 |
| 3.0 to 3.9 | 1 | 2 | 5 | .. | 8 |
| 4.0 to 4.9 | 1 | 1 | 3 | 2 | 7 |
| 5.0 to 5.9 | 2 | 2 | 2 | .. | 6 |
| 6.0 to 6.9 | .. | 2 | 2 | .. | 4 |
| 7.0 to 7.9 | 1 | .. | .. | .. | 1 |
| 8.0 to 8.9 | .. | .. | .. | 1 | 1 |
| 9.0 to 9.9 | .. | .. | .. | .. | .. |
| 10.0 to 10.9 | .. | 2 | .. | .. | 2 |
| 11.0 to 11.9 | .. | 1 | 1 | .. | 2 |
| 12.0 to 12.9 | .. | .. | .. | .. | .. |
| 13.0 and over * | 1 | 2 | 1 | .. | 4 |
| Total | 23 | 20 | 44 | 12 | 99 |
| | | | Basic series | | |
| 0.0 to 0.9 | 4 | .. | 2 | 1 | 7 |
| 1.0 to 1.9 | 7 | 4 | 11 | 5 | 27 |
| 2.0 to 2.9 | 2 | 4 | 9 | 1 | 16 |
| 3.0 to 3.9 | .. | 2 | 1 | .. | 3 |
| 4.0 to 4.9 | .. | 2 | 3 | .. | 5 |
| 5.0 to 5.9 | .. | .. | 1 | .. | 1 |
| Total | 13 | 12 | 27 | 7 | 59 |

* The items in this class are: agriculture and fisheries, 13.0 per cent; mining, 16.8 and 31.6 per cent; manufactures and construction, 16.7 per cent.

of 3.0 per cent or over, but only 2 manufactures from agricultural materials. On the other hand, 9 manufactures from agricultural materials have amplitudes of 1.5 per cent or less, but only 4 manufactures from mineral materials.

dustrial difference, then, is between agricultural products and their processed derivatives, on the one hand, and minerals and their derivatives, on the other; or what comes substantially to the same thing, between consumers' goods and producers' goods industries.[44]

These industrial differences in trend-cycle amplitude are traceable to four factors: type of technology and organization, type of demand, scope of industry, and its degree of maturity. The influence of the first factor can be detected in the difference between the trend-cycle amplitudes of the agricultural and mineral industries. In agriculture, the control over output is widely diffused, much of the output of each of the various products is an incidental result of activities carried on principally for other products, and managerial policy is such as to lead generally to an inverse movement in the trend-cycles of acreages and acre-yields.[45] Thus, those factors making for trend-cycles which arise in the technology and organization of agriculture operate through numerous channels, often work in different directions, and therefore are self-cancelling in considerable part; so that the trend-cycle amplitudes tend to be low. In contrast to agriculture, most mineral industries are characterized by fair concentration of control, and practically all of the output of most minerals results from activities carried on almost solely for those minerals. Therefore, those factors making for trend-

[44] Consumers' goods are viewed as products destined for human consumption, producers' goods as products which find final realization in industrial equipment. Of the 59 basic series (see Appendix A, Table 46, column *f*), 29 may be listed fairly unequivocally as consumers' goods series, and 14 as producers' goods series. The first group includes series 1, 5–6, 9–10, 13–5, 18–20, 23–4, 43, 46–50, 58, 66, 68, 71, 79–80, 82–3, 86, and 99; the second includes series 25, 27, 29, 34, 36, 39, 52, 56, 62, 73, 78, 85, 90, and 91. The median of the trend-cycle amplitudes of the consumers' goods series is 1.6 per cent, as is the arithmetic mean. The median of the amplitudes of the producers' goods series is 2.4 per cent, the arithmetic mean 2.6 per cent.

[45] See pp. 213–5.

## Table 39

MEASURES OF TREND-CYCLE AMPLITUDE

(Unit: one per cent)

| Series | Period covered by series | Trend-cycle amplitude |
|---|---|---|
| **Agriculture and fisheries** | | |
| Beet sugar | 1870–1929 | 13.0 |
| Raisins | 1872–1929 | 7.9 |
| Flaxseed | 1879–1929 | 5.0 |
| Rice | 1870–1929 | 5.0 |
| Rye | 1870–1929 | 4.1 |
| Whale | 1870–1929 | 3.7 |
| Molasses and sirup | 1870–1929 | 2.6 |
| Barley | 1870–1929 | 2.5 |
| Cane sugar | 1870–1929 | 2.5 |
| Tobacco, raw | 1870–1929 | 2.2 |
| Cattle | 1880–1929 | 1.8 |
| Cotton | 1870–1929 | 1.8 |
| Cod and mackerel | 1870–1929 | 1.7 |
| Sheep | 1880–1929 | 1.7 |
| Wool | 1870–1929 | 1.7 |
| Wheat | 1870–1930 | 1.4 |
| Oats | 1870–1930 | 1.3 |
| Buckwheat | 1870–1929 | 1.2 |
| Potatoes | 1870–1929 | 1.0 |
| Corn | 1870–1929 | 0.9 |
| Hogs | 1880–1929 | 0.9 |
| Fish, total | 1880–1929 | 0.8 |
| Hay | 1870–1930 | 0.8 |
| **Mining** | | |
| Sulphur | 1880–1929 | 31.6 |
| Asphalt | 1880–1929 | 16.8 |
| Non-Portland cements | 1880–1929 | 11.5 |
| Portland cement | 1880–1929 | 10.5 |
| Natural gas | 1882–1929 | 10.3 |
| Fluorspar | 1880–1929 | 6.9 |
| Mercury | 1870–1929 | 6.6 |
| Pyrites | 1880–1929 | 5.3 |
| Gypsum | 1880–1929 | 5.2 |

Table 39 (cont.)

MEASURES OF TREND-CYCLE AMPLITUDE

(Unit: one per cent)

| Series | Period covered by series | Trend-cycle amplitude |
|---|---|---|
| **Mining (cont.)** | | |
| Gold | 1870–1929 | 4.5 |
| Cement, total | 1880–1929 | 4.2 |
| Petroleum | 1870–1929 | 3.6 |
| Lead, domestic | 1870–1929 | 3.1 |
| Copper | 1870–1929 | 2.8 |
| Bituminous coal | 1870–1929 | 2.4 |
| Iron ore | 1880–1929 | 2.4 |
| Zinc | 1870–1929 | 2.1 |
| Coal, total | 1870–1929 | 2.0 |
| Phosphate rock | 1870–1929 | 1.9 |
| Salt | 1880–1929 | 1.7 |
| Silver | 1870–1929 | 1.6 |
| Anthracite coal | 1870–1929 | 1.2 |
| **Manufactures and construction** | | |
| Vessels | 1870–1929 | 16.7 |
| Aluminum | 1883–1929 | 11.6 |
| Cigarettes | 1880–1929 | 6.4 |
| Locomotives | 1880–1929 | 6.3 |
| Building permits | 1874–1929 | 5.9 |
| Antimonial lead | 1871–1929 | 5.4 |
| Rubber imports | 1870–1929 | 4.9 |
| Rail consumption | 1870–1929 | 4.1 |
| Steel | 1870–1929 | 4.1 |
| Sisal imports | 1870–1929 | 3.7 |
| Roofing slate | 1879–1929 | 3.6 |
| Gold consumption | 1880–1929 | 3.2 |
| Rails | 1870–1929 | 3.1 |
| Superphosphate | 1870–1929 | 3.0 |
| Canned corn | 1885–1929 | 2.9 |
| Lead, total | 1870–1929 | 2.7 |
| Cocoa imports | 1870–1929 | 2.5 |
| Cottonseed oil | 1872–1929 | 2.5 |

Table 39 (cont.)

MEASURES OF TREND-CYCLE AMPLITUDE

(Unit: one per cent)

| Series | Period covered by series | Trend-cycle amplitude |
|---|---|---|
| Manufactures and construction (cont.) | | |
| Rolled iron and steel | 1885–1929 | 2.5 |
| Cottonseed cake and meal | 1872–1929 | 2.4 |
| Flaxseed consumption | 1879–1929 | 2.4 |
| Jute imports | 1870–1929 | 2.3 |
| Silver consumption | 1880–1929 | 2.3 |
| Distilled spirits | 1870–1918 | 2.2 |
| Copper consumption | 1883–1929 | 2.1 |
| Pig iron | 1870–1929 | 2.0 |
| Tin-plate consumption | 1871–1929 | 2.0 |
| Zinc consumption | 1873–1929 | 1.9 |
| Manila hemp imports | 1870–1929 | 1.8 |
| Silk imports, raw | 1870–1929 | 1.8 |
| Coke | 1880–1929 | 1.7 |
| Minor fiber imports | 1870–1929 | 1.7 |
| Wool consumption | 1870–1930 | 1.6 |
| Coffee imports | 1870–1929 | 1.5 |
| Nails | 1872–1929 | 1.5 |
| Cigars | 1880–1929 | 1.4 |
| Fermented liquors | 1870–1918 | 1.4 |
| White lead | 1884–1929 | 1.4 |
| Canned tomatoes | 1885–1929 | 1.3 |
| Tobacco and snuff | 1871–1929 | 1.2 |
| Cotton consumption | 1870–1929 | 1.0 |
| Lead consumption | 1870–1929 | 1.0 |
| Raw sugar consumption | 1870–1930 | 1.0 |
| Silk imports, unmanufactured | 1883–1929 | 1.0 |
| Tin imports | 1870–1929 | 1.0 |
| Tobacco consumption | 1880–1929 | 0.9 |
| Flour | 1880–1929 | 0.5 |
| Transportation and trade | | |
| Shares traded | 1875–1929 | 8.0 |
| N. Y. canals traffic | 1870–1929 | 4.6 |
| S. S. Marie canals traffic | 1870–1929 | 4.1 |

Table 39 (cont.)
MEASURES OF TREND-CYCLE AMPLITUDE
(Unit: one per cent)

| Series | Period covered by series | Trend-cycle amplitude |
|---|---|---|
| Transportation and trade (cont.) | | |
| Railway passenger-miles | 1882–1929 | 2.5 |
| Agricultural exports | 1870–1929 | 2.1 |
| Postal money orders | 1870–1929 | 1.7 |
| Coastal trade | 1870–1929 | 1.6 |
| Tonnage entered and cleared | 1870–1929 | 1.6 |
| Deflated clearings | 1870–1929 | 1.4 |
| Railway freight | 1882–1929 | 1.4 |
| Railway ton-miles | 1870–1929 | 1.3 |
| Postage stamps | 1870–1929 | 0.9 |

cycles which arise in the technology and organization of mining are not self-cancelling to the same extent as in agriculture, and tend to make for large amplitudes. But the technological factors underlying mining resemble in some cases, most notably in the silver industry, those of agriculture: as the mining of the various ores containing silver is influenced by somewhat different causes, the trend-cycles in the various ores are partly self-cancelling, and silver production has consequently a low trend-cycle amplitude.

The powerful influence of type of demand on the trend-cycle amplitudes of industries is expressed in the lower amplitude of consumers' goods than of producers' goods industries, previously mentioned, and in the lower amplitude of industries producing consumers' staples than of luxury goods. Trends of consumption of consumers' staples are closely linked to the trend of population which is superlatively regular. Whatever secular changes take place in the per-capita consumption of staples tend to be gradual, in part, because

trend-cycles of real earnings are of mild amplitude,[46] but primarily, because staples are deeply ingrained in the customs of the people. In the case of luxury products, however, demand factors tend to make for large trend-cycle amplitudes, in part, because such products are 'marginal' in consumers' outlays, and in part, because fashions in their use are often volatile. Finally, the demand for producers' goods, being derived from the demand for consumers' goods, ordinarily exaggerates the secular variations in that demand, and therefore tends to make for large trend-cycle amplitudes. Thus, a change from, say, an upward to a downward trend-cycle movement will tend to be accompanied by a sharp curtailment in capital extensions, since a diminished rate of growth in the production of consumers' goods means that the productive facilities extended earlier on the basis of the former higher rate of growth in production can amply provide for the moderately increasing demand for some years. Delays will also tend to take place in repairs and replacements, for the overextension of capital facilities makes shifts possible to idle equipment in good condition. These factors make for a very sharp downward trend-cycle movement in producers' goods industries, but they do not hold sway exclusively and are counteracted, though only in part, by other factors: only a limited number of enterprises provide capital facilities for their anticipated growth over a long period, new industries require instrumental equipment, and a period of general trend-cycle contraction is yet a period of trend-cycle expansion for a goodly number of industries.

The lower trend-cycle amplitude of basic than of non-basic series is traceable to differences in the scope and maturity of the industries in the two groups. The broader the industrial coverage of a series, the more potent are the influences mak-

[46] The trend-cycle amplitude of an index of real earnings (see p. 240, note 53) is 0.8 per cent for 1890–1926.

ing for a low trend-cycle amplitude. For when the composite demand for a good is wide and diversified, the various components of that demand are likely to be subject to trend-cycle movements which are to some extent antithetical; the output of that good is therefore likely to have a small trend-cycle amplitude. On the other hand, the demand for a specialized commodity flows through a single channel or a limited number of channels; the output of that good is therefore likely to have a large trend-cycle amplitude. The influence of the industrial scope of a series on its trend-cycle amplitude is continuous and works within and across the groups of basic and non-basic series. Thus, the basic series of greatest industrial coverage or reference—such as deflated clearings, railway freight, railway ton-miles, and postage stamps—have exceptionally low trend-cycle amplitudes. Where aggregate series and their components are both included in our list of series, the aggregate series generally have the lower amplitudes.[47] In the simple industrial sequences represented by the production of a raw material and its industrial consumption, the consumption series have a wider industrial reference and generally have also the lower amplitudes.[48]

Finally, the trend-cycle amplitude of an industry tends to reflect its age or degree of maturity. The trend-cycles of 'mature' industries tend to be of mild amplitude: since the

[47] Coal is an exception, but this results from the very high direct correlation between the trend-cycles of anthracite and bituminous.

[48] Of nine such sequences among our series (see p. 166), all but two—copper and silver—conform to the rule stated; and it is of some significance that the ores of these two metals are generally combined with other ores. The present comparisons are based on periods which are identical for the production and consumption of each commodity, but different for the several commodities. Special computations of trend-cycle amplitudes were necessary for certain of the series. They are as follows for the periods indicated: copper (1883–1929), 1.6 per cent; zinc (1873–1929), 2.1 per cent; silver (1880–1929), 1.7 per cent; gold (1880–1929), 4.0 per cent; and raw tobacco (1880–1929), 2.1 per cent.

absolute size of their output is large and the slopes of their primary trends are mild, even appreciable changes in the volume of production are likely to mean only small changes in their percentage rates of growth. On the other hand, the trend-cycles of 'new' and 'decadent' industries tend to be of large amplitude: since the absolute size of their output is small and the slopes of their primary trends are sharp, at least during the phases of infancy and late retrogression, even minor changes in the volume of production are likely to mean considerable changes in their percentage rates of growth. Since high average rates of growth or of decline equally imply considerable capacity for variation over time in the rates of growth, a rectilinear relationship cannot be expected to hold between the average rate of growth, previously accepted as a rough indicator of industrial maturity, and the trend-cycle amplitude of industries; but it may be expected to hold for the consistently progressive or retrogressive divisions of industry—or to use the terminology earlier employed, for series with measures of continuity of growth of +1 or −1.[49]

Table 40 indicates that our statistical records consist with these expectations.[50] The coefficients of correlation are negli-

[49] See pp. 74–6.

[50] The 5 series having the highest trend-cycle amplitudes and the 5 having the highest average rates of growth (for the full period covered) were omitted from the 'all' series group (see Appendix A, Table 46, column *e*); since 3 series had extreme values for both variables, only the following 7 series had to be dropped: 2, 16, 35, 41, 44, 65, and 84. The last 5 series were dropped also from the nonagricultural group (see Table 46, column *g*). For the composition of the basic and basic nonagricultural groups, see Table 46, columns *f* and *h*; of the basic consumers' goods and basic producers' goods groups, see p. 229, note 44. The group with measures of continuity of growth of 1.00 includes series 19, 29, 31, 36, 38, 43, 46–7, 52–3, 58–9, 62–4, 68, 73, 82–3, 85–6, 88, 90, 95–7, 101, and 104. The group with measures of continuity of growth from .50 to 1.00 includes series 1, 5–14, 18, 20, 23–5, 27, 32, 34, 37, 39, 42, 45, 48–50, 54, 56, 61, 66–7, 69–72, 74, 76–80, 87, 89, 93, 98–99, and 102. The group with measures of continuity of growth below .50 includes series 3–4, 15, 17, 21–2, 28, 30, 33, 40, 51, 57, 75, 81, 91–2, 94, 100, and 103. (In all, the last 3 groups include 94

gible for the 'all' series and nonagricultural groups, because the high positive correlation for the rapidly growing industries is cancelled by the negative correlation for decadent

Table 40

COEFFICIENTS OF CORRELATION BETWEEN AVERAGE RATES OF GROWTH AND TREND-CYCLE AMPLITUDES, FOR SEVERAL GROUPS OF PRODUCTION SERIES

| Group | Number of series included | Coefficient of correlation |
|---|---|---|
| 'All' series | 92 | .14 |
| Nonagricultural series | 70 | .07 |
| Basic series | 59 | .39 |
| Basic nonagricultural series | 46 | .29 |
| Basic consumers' goods series | 29 | .48 |
| Basic producers' goods series | 14 | .31 |
| Series with measures of continuity of growth of 1.00 | 28 | .72 |
| Series with measures of continuity of growth from .50 to 1.00 | 47 | .66 |
| Series with measures of continuity of growth below .50 | 19 | .09 |

industries and the absence of correlation for industries in the twilight zone of progress. On the other hand, the coefficients are fairly high for the basic and basic nonagricultural groups, because none of the industries in these groups show an average rate of decline and a smaller number are in the twilight zone of progress, so that only a part of the correlation for the progressive group is cancelled.[51] But the most illuminating

series, which is two more than is contained in the 'all' series group with extremes dropped. Series 36 and 83, which were dropped earlier because of their duplicative character—see p. 52, note—are retained in the group with measures of continuity of 1.00 because they do not involve there any duplication.)

[51] The coefficients for basic consumers' goods and basic producers' goods

coefficients are for the several groups of series of varying degrees of progressiveness as indicated by measures of continuity of growth: the correlation is seen to decline with the continuity of growth of the series. In the progressive division of industry, then, the industries having grown relatively at the highest rates tend to be the same as those having relatively the highest trend-cycle amplitudes; and the industries having grown at the lowest rates tend to be the same as those having the lowest trend-cycle amplitudes.[52]

---

are of the same order of magnitude as the coefficient for the entire basic group; this indicates that the correlation in the basic group does not reflect merely the lower (average) rate of growth and lower trend-cycle amplitude of consumers' goods than of producers' goods series.

[52] The correlation study indicates emphatically that the average rate of growth, taken algebraically, does not bear a linear relationship to trend-cycle amplitude. Yet, if the average rate of growth—which may be viewed as an index of the potential capacity for variation in the characteristic represented by a series having positive values throughout—is replaced by a generalized and more significant index of capacity for variation, a consistently linear relationship does emerge between trend-cycle amplitude and such a modified measure. A general index of capacity for variation may be readily secured by observing a few elementary points. It is accepted in Statistics that the average value of a series is an index of the capacity of the series to vary; otherwise, there is no sense in taking an average as the denominator of the coefficient of relative variability. Yet, an average can logically serve, as an index of capacity for variation, only in the case of a series with positive values. When all items are negative, a negative capacity for variation would be indicated, which is nonsense. When positive and negative items balance exactly, that is, when their arithmetic mean is zero, we have the paradox of a series having no capacity for variation showing nevertheless infinite relative variation. These considerations point to the necessity of redefining just what it is which measures the capacity of a series to vary.

The characteristic of potential variability can be determined statistically from only the direct behavior of a series—that is, if there is no a priori knowledge of the causes making for its variability. Every individual departure of a series from zero constitutes an observation on the capacity of the series to vary. Therefore, an average deviation or a standard deviation measured from zero expresses synthetically the degree of potential variation. An average deviation from zero is simply the arithmetic mean of the series when all items are positive; this means that the average deviation from zero is a general measure of potential capacity for variation, containing the arithmetic mean as a special case when all items are positive. But the standard deviation from zero is a preferable measure of capacity

## V. THE EXPLANATION OF TREND-CYCLES

An attempt has already been made in section III to explain the individual character of the trend-cycles in agriculture, and also the various departures of nonagricultural series from the standard trend-cycle pattern. We must now direct our attention to the causes of the similarities among the series—that is, the trend-cycle rhythm proper. Presumably, the trend-cycles of production tend to run a similar course in the various industries because of their technical and commercial interdependence. The interconnection of economic processes

---

for variation; for it bears a definite mathematical relation to the standard deviation taken from the mean and to the standard deviation taken from a line of trend: the latter two cannot be greater than the former. (One implication is that the coefficient of relative variability can be expressed as the ratio of a standard deviation measured from the mean to a standard deviation measured from zero.)

It is to be expected that a coefficient of correlation between this index of capacity for variation and trend-cycle amplitude will be higher than that between the average rate of growth and trend-cycle amplitude. In fact, the correlation for the 'all' series group (see note 50) now becomes .69, while it was formerly only .14. Similarly, the correlation for the basic series group is raised from .39 to .61. The high relationship between indexes of trend-cycle amplitude and indexes of capacity for variation means simply that the potential capacity of the rate of growth of an industry to vary is actually realized in a fairly consistent degree by the ensemble of series. Of itself, this is not very important; but it provides indirectly a useful standard for the segregation of series that have realized to an exceptionally large or small (relative) extent the potential capacity for variation in the rates of their development. Such a standard may be taken to be defined by the zone traced out by the 'standard error' measured on each side of the line of regression of trend-cycle amplitude on the index of capacity for variation. The series of the basic group lying above this zone are gold, gold consumption, rail consumption, building permits, and rubber imports: these are series whose actual trend-cycle amplitude is 'abnormally' large in relation to their potential capacity for variation. The series lying below the zone are cottonseed oil, phosphate rock, tin imports, unmanufactured silk imports, postage stamps, and railway ton-miles: these are series whose actual trend-cycle amplitude is 'abnormally' small in relation to their potential capacity for variation. Only this conclusion is warranted: when the capacity for variation in the rate of industrial growth is considered, the construction series have exceptionally large trend-cycle amplitudes, while the series of broadest industrial reference have exceptionally small trend-cycle amplitudes.

in turn suggests that the standard trend-cycle cannot be confined to the sphere of physical production alone, that it must pervade as well all other major elements in the economy. A brief study of series relating to economic processes other than production—nonagricultural prices, 'all-commodity' prices, real earnings, money in circulation, gold stocks, business failures, and patents issued—shows (see Chart 20) that such series do in fact run a trend-cycle course similar to that of the standard trend-cycle.[53] There is some evidence, then, that the

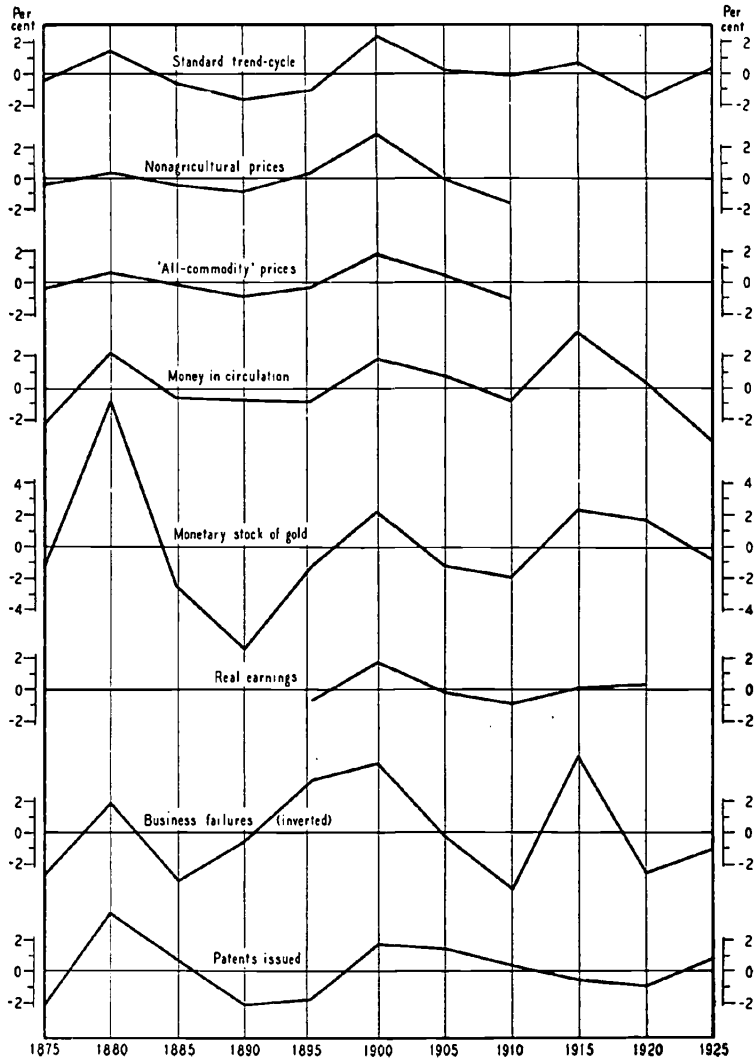
[53] The indexes of trend-cycle conformity of the series are as follows: nonagricultural prices 1.00, 'all-commodity' prices 1.00, real earnings .60, money in circulation .60, gold stocks .80, business failures (inverted) .80, patents issued .80.

The trend-cycles of these non-production series were determined in the same way as the trend-cycles of the production series, except that, in the case of the price indexes, the deviations of the decade rates were taken from natural straight lines. (This minor technical departure was resorted to, because there is no sense in considering the primary trend of prices as a 'logarithmic' parabola. The results obtained do not differ perceptibly from those yielded by an exponential curve fitted to the decade rates.) The trend-cycles of the price indexes are not given beyond the central decade year 1910, since decade rates for the later period of violent price movements would be fictive. However, if trend-cycles of the price indexes were computed for the later years, they would continue to conform to the standard trend-cycle. The failure of the wage series to cover the full period since 1870 is due to absence of data.

For the figures corresponding to Chart 20, see Appendix A, Table 53. The curve in Chart 20, headed 'standard trend-cycle' is a graph of the arithmetic means of the nine decil curves of the basic nonagricultural group (Section 4, see Chart 8D and Table 48). The other curves in Chart 20 are based on the following data: (1) Nonagricultural wholesale prices: 1870–90, index by Bureau of Agricultural Economics, derived from the Aldrich report indexes, the foods group being excluded; since 1890, an index furnished by Professor Mills (this index is an unweighted geometric of relatives of nonagricultural prices, manufactured derivatives of farm products not being included). (2) 'All-commodity' wholesale prices: 1870–89, the Aldrich report index; beginning with 1890, index of the Bureau of Labor Statistics. (The Warren-Pearson index of wholesale commodity prices—see New York State College of Agriculture, *Farm Economics*, September, 1931, pp. 1586–7—gives much the same results for the period 1870–90 as the notorious Aldrich index.) (3) Real earnings: this is an index of real earnings (not real wages) of employees "attached to the manufacturing, transportation, and coal-mining industries." See P. H. Douglas, *Real Wages in the United States, 1890–1926* (Pollak Foundation for Economic Research, 1930), p. 468. (4) Money in circulation: this series covers money in circula-

## Chart 20

TREND-CYCLES OF PROCESSES OTHER THAN PRODUCTION COMPARED WITH STANDARD TREND-CYCLE



impress of the standard trend-cycle is diffused generally through the economic system; though only a thorough statistical study of processes other than production could establish satisfactorily the pervasiveness of the standard trend-cycle. A serious inquiry into the causes of trend-cycles in production must await this larger fact-finding study.

There is, however, one set of factors bearing on the causation of trend-cycles, which our study, restricted though it is to production data, does bring to light. Chart 21 presents, at each central decade year, measures of dispersion of the decade rates of two groups of production series. These measures of dispersion are 'adjusted' for their downward bias, and therefore constitute fair indicators of the oscillations in the divergence of production trends in the total economy.[54]

---

tion outside of the Treasury (including that held by Federal reserve banks and agents), as of June 30. See *Annual Reports of the Secretary of the Treasury*. (5) Monetary stock of gold: this series relates to June 30; it "does not include gold bullion and foreign coin outside of the vaults of the Treasury, Federal reserve banks, and Federal reserve agents." See *Annual Reports of the Secretary of the Treasury,* particularly the report for 1928. (6) Business failures: this series covers number of failures of manufacturing and commercial concerns, but not banks. See *Dun's Review*. (7) Patents issued: this series is for total patents issued (patents, designs, and reissues). See *Annual Reports of the Commissioner of Patents*.

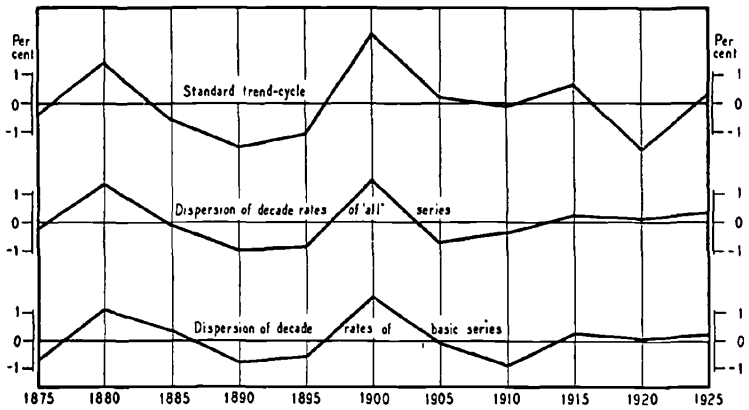
[54] Measures of dispersion of decade rates were calculated at each central decade year, for several groups of production series. In calculating the dispersion of the decade rates, it was undesirable to take account of the full numerical values of the individual items, because these are often erratic at the ends of the distributions. Therefore, the measure of dispersion of the decade rates for a given decade in a given group of series was computed from the formula: $\frac{D_7 + D_8 - D_2 - D_3}{2}$, where the D's and their subscripts refer to decils of decade rates. (These decils are for the decade rates proper, and are not to be confused with the decils, described on pp. 182–3, of the deviations of the decade rates from exponential curves fitted to them.) This measure is virtually equivalent to the interquartile range, but is apt to be more stable. The dispersion measures for the 'all' series and basic series groups are given in Appendix A, Table 54.

The measures of dispersion for each group of series showed a downward drift with the march of time, suggesting that the rates of growth of the various industries were becoming increasingly similar. This is contrary to

It will be noticed that the cyclical movements of the dispersion measures trace out patterns very similar to that of the standard trend-cycle. This correspondence means that when the trends of production have on the whole moved steeply upward, the degree of divergence of production trends has

Chart 21

CYCLES OF DISPERSION OF DECADE RATES OF PRODUCTION SERIES COMPARED WITH STANDARD TREND-CYCLE




also been high; and that when the trends of production have on the whole moved only moderately upward, the degree of divergence of production trends has also been only moderate. In fine, the degree of divergence of production trends has varied with the degree of progressiveness of the economy.

---

expectations, for technical progress and rising standards of living work incessantly in the direction of increasing the divergence of production trends. The downward drift is a bias which originates in the fact that the forces making for retardation in industrial growth tend to act most potently in the more rapidly growing industries, so that the rates of growth of a virtually fixed list of individual industries tend to become increasingly similar as the length of period covered increases. It was necessary to adjust the measures of dispersion for their bias; this was done by expressing the decade-by-decade dispersion measures of a given group as plus or minus deviations from a straight line fitted to the dispersion measures by the method of least squares. These deviations constitute the cycles of dispersion: they are

The divergence of production trends over periods of some ten years has a different meaning than over periods of a half-century or longer: the latter indicates the extent of the actual transformation in the pattern of national production, the former indicates partly a real (lasting) transformation in the pattern of production and partly a disruption of the 'normal' relationships among industries. A certain degree of trend divergence is a necessary condition of smooth development in a progressive economy; for, in such an economy, the ratio of manufactured products to raw materials will tend to increase, as will the ratio of instrumental equipment to final consumers' goods, and of 'comforts' and 'luxuries' to 'necessaries'. In actual experience, however, the degree of divergence of production trends will be generally either more or less than 'normal'; that is, either more or less than is warranted by changes in the technical relations of commodities and in consumers' habits; more or less than is necessary for an uninterrupted rate of development, or an uninterrupted change in the rate of development, in the general economy. When during an upward trend-cycle movement the divergence exceeds what is 'normal' for the time, a strain will develop in the economic system; this is likely to lead to a general

plotted in Chart 21 for the 'all' series and basic series groups (for the exact decade-by-decade composition of these groups, see pp. 180–1, note 8); the figures corresponding to the chart are given in Table 54.

Cycles of dispersion measures determined for identical lists of series of the above two categories (see groups *a*, *b*, *e*, and *f*, in Table 46) showed practically the same type of fluctuation as the groups in Chart 21. On the other hand, cycles of dispersion measures for nonagricultural groups of series (see groups *c*, *d*, *g*, and *h*, in Table 46, and the nonagricultural groups noted on pp. 180–1, note 8) departed considerably from the standard trend-cycle. This fact is important: in the first place, it renders suspect the easy interpretation that the similarity of the cycles in the dispersion measures (plotted in Chart 21) to the standard trend-cycle emanates from the mere circumstance that dispersions are apt to be closely correlated with averages; in the second place, it lends support to the a priori expectation that, if divergence of production trends is a causal factor in trend-cycle movements, it must be the divergence of the trends of all industries rather than of nonagricultural industries alone.

crisis and to a curtailment in the rate of development of the system. The unique correspondence, then, between relatively sharp divergence of production trends and an upward trend-cycle movement in industry suggests that one of the factors serving to terminate an upward trend-cycle movement is a partial loss of industrial balance that develops during the upward movement.

When the divergence of production trends falls below what is 'normal' for the time, it might of itself indicate either increasing strain in the system or increasing approach to industrial relationships 'normal' for that time. But when the divergence of production trends falls to a 'subnormal' level during a downward trend-cycle movement, it is practically certain to be symptomatic of increasing readjustment; for the 'subnormal' degree of divergence will then derive mainly from the sharp curtailment in the rates of development of those industries which had grown at a disproportionately rapid rate during the upward trend-cycle movement. Although the divergence of production trends is invariably lower during a downward than during an upward trend-cycle movement, it may yet, for all that we know, remain above 'normal' for some time. This may express either a very rapid readjustment of industrial trends or an increasing strain in the industrial system, depending on the particular relative positions of the individual trends; but if the latter be the condition, it cannot continue indefinitely, and with the passage of years, a realignment of industrial rates of growth favorable to the inception of a 'new era' is virtually bound to emerge. The unique correspondence, then, between relatively mild divergence of production trends and a downward trend-cycle movement suggests that a restoration of industrial balance develops during the downward movement, which creates conditions favorable to (or permissive of) the initiation of a new upward movement.

This is the sum of light which our data throw definitely on the causation of trend-cycles in production. The correspondence between the trend-cycles of several non-production series and the standard trend-cycle (Chart 20) suggests, of course, other hypotheses, such as that trend-cycles in monetary supply and in prices generate the trend-cycle in production, or that trend-cycles in technical progress (the series 'patents issued' probably serves well enough as an index of technical progress, in decade comparisons) generate trend-cycles in production. However, statistical correlations cannot lend to such theories any sort of real support; for the correlations might also be plausibly interpreted as indicating that trend-cycles in production generate trend-cycles in prices and in technical progress. Furthermore, any linear theory of trend-cycles in production is likely to be faulty: the connections between economic processes are seldom of the nature of mechanical sequences, and, if it be true that the standard trend-cycle is diffused through the entire economic system, it is unlikely that there is an independent rhythm in some one part of the system, which causes a rhythm in the entire economy. In analyzing the relation between variations in the degree of divergence of production trends and trend-cycles in production, we have called attention to but one factor in the causation of trend-cycles in production; but it is worth noting that this factor implies an organic relation among industrial trends, and does not presuppose any linear chain of causation.

We may reasonably expect that when the study of trend-cycles is extended to economic processes other than production, it will become possible to describe with some exactness the mechanism of the trend-cycle process. To go any further now than we already have would be to excogitate hypotheses unlikely to carry conviction to any discerning inquirer. Nevertheless, one partial hypothesis—as yet an intuitive conjecture and no more—may be ventured. The partial hypothe-

sis is that accidental forces play a large rôle in trend-cycle movements. In formal terms, an upward trend-cycle movement is likely to be initiated, provided industrial relationships are favorable, by a single accidental cause operating in the same direction over a number of years (such as a continuing increase in the quantity of gold or a persisting shortage in construction), or by numerous independent accidents cumulating in the same direction over a number of years; and a downward trend-cycle movement is likely to be prolonged by random factors. In the light of what has previously been stated, this partial hypothesis implies that there might be a plateau of some duration between one trend-cycle and the next. These closing observations are, it is necessary to insist, entirely unsupported; the main, if not the sole, contribution of this chapter lies in the problem which it poses.

## VI. RELATION OF TREND-CYCLES TO BUSINESS DEPRESSIONS

'Business cycles' are closer to direct experience than trend-cycles; that is the primary reason why business cycles are so generally recognized, while trend-cycles have not as yet won, and rightly so in view of their restricted study, common acceptation. But it appears that business cycles are short-term waves in national economic life which are superimposed on the long-term waves that we have designated as trend-cycles.[55] These two types of cyclical movement are not independent of each other. The preceding study of the relation between trend-cycles and divergence of production trends

[55] As the study of economic fluctuations progresses, our cyclical terminology will have to be altered. 'Trend-cycles' and 'business cycles' are equally cycles in *business*; so are 'seasonal cycles' in economic activities, for they tend to synchronize roughly within such broad industrial groups as manufacturing and distribution (see S. Kuznets, *Seasonal Variations in Industry and Trade*, National Bureau of Economic Research, 1933, Ch. IX).

enables us to trace tentatively one important connection between them.

We have seen that a sharp divergence of production trends develops during an upward trend-cycle movement, and have argued that the disparity in production trends sows the seeds of a reversal in the trend-cycle movement. Although the process of reversal cannot as yet be described, one symptom of the process of reversal may be suggested. Is it not likely that, once an upward trend-cycle movement has continued for some time, the strain and loss of industrial balance will culminate in a general economic crisis serving to terminate the upward movement? In one form or another, this hypothesis is a very old one. It has frequently been argued that the severity of a business depression is correlated with the intensity of the period of expansion preceding it, though reference is generally had to the preceding upward phase of the business cycle rather than to secular movements. Another common theory is that the degree of severity of a business depression is associated with the divergence in the rates of advance in production during the preceding period; though here again, reference is generally had to the divergence of cyclical rather than secular rates of expansion. The hypothesis relating business depressions to trend-cycles cannot be attacked very confidently with the statistical tools of the present study, for these were forged mainly with a view to other purposes. Still, the decade rates furnish an instructive tentative approach to the problem.

The first peak in the standard trend-cycle and in the cycle of divergence in production trends comes in the decade 1875–85. In April 1882, a severe business depression set in, which lasted through May 1885. The depression occurred towards the end of the decade during which the standard trend-cycle and the cycle in the dispersion of the decade rates reached a peak. But the rates of production growth and their

dispersion would not differ very much for a period of some eight to ten years immediately antedating the depression. This is to be expected from the fact that the cyclical factor was corrected for in the computation of the decade rates; and the expectation is confirmed by the charts of the individual production series. The statistical record in the present case is therefore roughly consistent with the hypothesis that the severity of business depressions is connected with the magnitude of the preceding secular advance in general production and the divergence in the rates of secular advance of individual industries.

The second peak in the standard trend-cycle of production and in the cycle of divergence in production trends comes in the decade 1895–1905. This decade experienced extraordinarily rapid and almost uninterrupted growth. The annual charts for the more important nonagricultural series show virtually a continuous rise from 1896 to 1907. The setbacks in 1900 and 1903–04 are almost imperceptible in annual production data, and are of a quite different order of magnitude from the decline during the depression of 1907–08. Though this depression was of rather brief duration, running over some thirteen months from June 1907 through June 1908, it was of very considerable depth. Again, the statistical record confirms the hypothesis that a severe depression tends to follow a period during which the secular trends of production move sharply upward while the divergence in the rates of expansion is exceptionally large. It may reasonably be stated, and with even greater assurance for the present than for the previous case, that a plausible change in the time location or duration of the period for which rates of industrial growth might be studied in relation to the crisis of 1907–08 could not alter to any appreciable extent the general results.

The next peak in the standard trend-cycle comes in the

decade 1910–20. The peak for this period is not quite so significant as for other periods, since a considerable number of individual industries, especially those connected with construction, registered troughs. A more important characteristic of this period is the considerable diversity in the rates of industrial expansion—a natural consequence of the shifts in the economy from a peace to a war basis. The dispersion of the rates of production growth was probably greater than Chart 21 suggests. For the present purpose it suffices to state that the statistical evidence again satisfies our hypothesis; for this decade terminated with a crisis of extraordinary severity, the downturn lasting from February 1920 to September 1921.

The following and final peak in the standard trend-cycle and in the cycle of the dispersion in the rates of secular expansion comes in 1920–29. This is not an anomaly, as the trend-cycle observations relate to overlapping decades. Though we cannot be certain that a peak actually occurs in 1920–29, the statistics of production since 1925 suggest strongly that the level of the standard trend-cycle for the central decade year 1930 will compare unfavorably with that for the central decade year 1925. The peak of the cycle in divergence of production trends is not very impressive for the last decade; but the statistical series analyzed, being virtually fixed in number, have a smaller area of direct production reference for this period than for any other, and it is therefore likely that they are least representative for this period. It is a matter of common knowledge that differences in rates of industrial growth were very considerable during the last decade. Some industries of large magnitude, such as automobiles, rayon, radios, and electrical household devices, grew at excitingly rapid rates; other industries, such as men's clothing, sole leather, boots and shoes, certain knit goods, and certain lumber manufactures, experienced little growth or actual decline; but none of these are included among the

statistical records we have analyzed. It is highly probable, then, that the divergence of production trends during 1920–29 was much greater in fact than our long-term series suggest. This decade of rapid advance in production and curious contrasts in rates of expansion came to a close with what is, if the rough statistical indicators available are to be trusted, the severest depression in the history of the nation. Beginning in July 1929, the contraction in business has continued relentlessly; and although since April of this year (1933) the curve of business has shown signs of vigorous revival, it is not certain that the trough of the depression has been reached even yet. Apparently, our hypothesis is borne out also by the experience of the last decade.

There are only two severe depressions since 1870 which have not been reviewed, those of 1873–79 and 1893–94. The first does not admit of a test of our hypothesis, since this study does not go back far enough. As for the depression of 1893–94, it was preceded neither by a trend-cycle expansion nor by very marked divergence of production trends. Not every severe depression, then, has an upward trend-cycle movement as an antecedent. Many other factors may conduce to this result; the severity of the depression of 1893–94 being traceable to the intense uncertainty of the business community, both here and abroad, concerning the stability of our monetary system. We may therefore conclude from our analysis of American experience since 1870: first, that periods of sharp advance in the trend of general production, which are characterized invariably by considerable divergence in production trends, have been followed invariably by severe business depressions; second, that most of the business depressions of marked severity have been preceded by a sharp advance in the trend of general production and considerable divergence in the trends of individual industries.

We must, however, recognize fully the tentative nature of

this conclusion. The analysis is based on a limited range of historical experience; the hypothesis should therefore be checked by data for earlier years, and what is even more important, by data for recent decades of other highly industrialized countries. Moreover, the statistical instruments which we have used in attempting to verify the hypothesis are extremely crude. The dating of cyclical depressions should determine the periods to be analyzed, rather than the reverse which has been our procedure. The proper length of the periods for which rates of growth in production are to be studied is a nice question; but it cannot be handled adequately by an arbitrary and non-experimental method. And for more recent decades much fuller materials are available than we have used, our list of series having been determined by their availability over a rather long period. Nevertheless, the consilience of such statistical records as we have examined and of theoretical expectations is sufficiently close to warrant more attention to the relation between production trends and business depressions than has been possible in the present work.