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Chapter III

THE CHANGING PATTERN OF PRODUCTION

THE outstanding characteristics of the economic progress in the United States since the Civil War have been increase and change in wants and activities. The total volume of national production has increased rapidly, as has the volume of production of major industrial groups. But the rate of advance has been uneven in the various individual industries, and in any one industry at various times. The growth of general production has therefore been accompanied by a continual transformation of its pattern. With the incessant introduction of new commodities and services, disappearance of old commodities, and shifts in the relative importance of continuing products, vast changes have occurred in the qualitative composition of national industry. The aim of this chapter is to present, so far as our limited list of production series will permit, a general description of these changes.

I. DIVERGENCE OF PRODUCTION TRENDS

Two methods might be used in presenting a statistical picture of changes in the pattern of production. One is to determine at given dates the relative contribution of the various individual industries to the aggregate of national output. The other is to compare the rates of growth of the individual industries either at given dates or over given periods of time—more precisely, to compare the instantaneous or average percentage rates of advance of the secular trends of the various

industries. The first method presupposes the possibility of commensurating the outputs of different industries; [1] however, since any commensuration must be executed in terms of a single attribute of the produced goods, it will inevitably be, in some degree, unsatisfactory. The first method presupposes also that statistical records of the outputs which are to be commensurated are available in sufficient abundance to yield significant aggregates of production, but statistical data fall short considerably of this desideratum. It is practically impossible, then, to determine the changing contribution of individual industries to the total stream of production; though this might be done for that portion of the total production which is covered by the statistics, or for the production of certain industrial groups. With data restricted in quantity and not admitting of satisfactory general commensuration, it is preferable to use the second and theoretically inferior method, that of comparison of rates of industrial growth.

1. Statistical Record of Divergence

A telescopic view of the changes in the pattern of national industry will be obtained by comparing the average rates of advance of our series during the period investigated. The average annual rate of growth of each industry has been determined by taking an arithmetic mean of its decade rates.[2]

[1] General commensuration of 'produced' goods can be accomplished in terms of value or of expended labor; these are the only measurable aspects possessed by all 'produced' goods. However, partial commensuration, that is, for limited branches of industry, can be accomplished in other units: for the class of commodities, in terms of weight or cubic content; for the subclass of foods, in terms of calories (or British thermal units)—such a study covering a considerable number of years is now contemplated by Dr. Baker of the Department of Agriculture; for the subclass of fuels, also in terms of calories (or British thermal units)—such a study is reported in *Mineral Resources*, 1929, Part II, p. 699. See Ch. I, sec. I, and Ch. VI, sec. I.

[2] An average calculated in this way is influenced to a smaller extent by erratic values than an average yielded by an exponential curve fitted to the full period of the series, though the two methods lead generally to closely similar results. Theoretically, an arithmetic mean of decade rates is inferior

Average rates have been computed for the period 1885–1929 which is covered by all the series,[3] in order to achieve strict comparability among them; and additional averages have been struck for whatever periods the individual series embrace, in order to utilize the statistical records to the full. The degree of divergence in these average rates of advance will serve to indicate the extent to which the pattern of production has undergone modification. It must be noted, however, that even if the ratios of all inter-industry physical outputs remained constant, which would be the case if the physical outputs of all industries grew at the same percentage rate, the relative contributions of the different industries to the stream of production might still be inconstant from the standpoint of some such measure of output as 'net value product'.

A summary of the average rates of industrial growth is presented in Table 3 and Chart 1. Two frequency distributions are given, one comprising the rates[4] of advance of 64 production series over the period 1870–1929, and the other the rates of advance of 99 production series over the period 1885–1929.[5] This summary shows that the rates of increase of the

to a geometric mean: first, because an arithmetic mean of percentages has an 'upward bias'; second, because only a geometric mean of the 'slopes' of a number of spliced exponential curves can yield trend values at the first and last dates of the entire period, which are identical with the trend values, defined by the subperiod exponential curves, at those dates. However, the second advantage is nominal since the decade rates refer to overlapping periods; and apart from the overlapping, the exponential curves, implicit in the decade rates, are not spliced (see Ch. II, sec. II, 2). The first advantage is of slight importance in view of the restricted range of variation of the decade rates (in the averaging process, the decade rates are, essentially, taken in ratio form, that is, as 1.054, 1.047, and so on, not as 5.4 per cent, 4.7 per cent, and so on). The arithmetic mean of decade rates therefore recommends itself on grounds of simplicity in computation.

[3] Except fermented liquors and distilled spirits, which terminate in 1918.

[4] The term 'rate' is used synonymously with 'average rate', 'average annual rate', and 'average annual percentage rate', throughout this chapter and also in section II of Chapter VI.

[5] Though a few of the 64 series do not extend to 1870, all go back sufficiently far to allow the computation of 'decade rates' for 1870–80. This group

Table 3

FREQUENCY DISTRIBUTIONS OF AVERAGE RATES OF INDUSTRIAL GROWTH, DURING 1870–1929 AND 1885–1929

Average annual rate of growth (per cent)	1870–1929		1885–1929	
	Number of series	Percentage of series	Number of series	Percentage of series
−5.0 to −3.1	1	1.6	1	1.0
−3.0 to −1.1	3	4.7	4	4.0
−1.0 to 0.9	3	4.7	9	9.1
1.0 to 2.9	24	37.5	29	29.3
3.0 to 4.9	6	9.4	28	28.3
5.0 to 6.9	13	20.3	15	15.2
7.0 to 8.9	10	15.6	7	7.1
9.0 to 10.9	2	3.1	2	2.0
11.0 to 12.9	..	...	..	...
13.0 to 14.9	..	...	..	...
15.0 to 16.9	2	3.1	1	1.0
17.0 to 18.9	..	...	1	1.0
19.0 to 20.9	..	...	..	...
21.0 to 22.9	..	...	..	...
23.0 to 24.9	..	...	2	2.0
Total	64	100.0	99	100.0

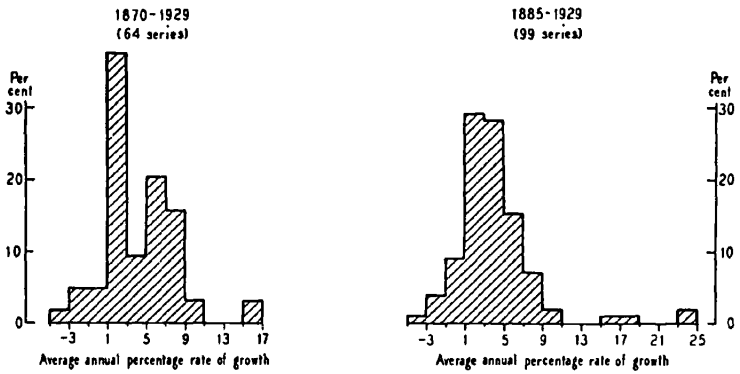
various industries have been sharply divergent during the period covered. The middle half of the rates of the 64 series covering the period since 1870 fall within the range from 2.0 to 6.5 per cent. How great a transformation this indicates in the structure of American industry may be gathered from the fact that if two industries had each 100 units of output in 1870, but one grew at a constant annual rate of 6.5 per cent and the other at a rate of 2.0 per cent, the first would be

does not include certain duplicative series which go back to 1870—total coal, and minor fiber imports. The group of 99 series contains all of the series listed in Table 1, except for five duplicative series. This group will be referred to as the 'all' series group without further qualification. The exact composition of the two groups is stated in Appendix A, Table 46, columns *a* and *e*.

producing over thirteen times as many units as the second by 1929. And as a matter of fact, the change in the pattern of our national industry has probably been very much greater than the frequency distributions suggest; for they are restricted to continuing industries, and exclude completely the new industries which have appeared and the old industries which have vanished—that is, the most dynamic portions of the production system.

Chart 1

FREQUENCY DISTRIBUTIONS OF AVERAGE RATES OF GROWTH DURING 1870-1929 AND 1885-1929



The detailed record of the variations among the rates of industrial growth is presented in Tables 4–8. These tables do not exhaust the range of industry; inadequate data account for the omission of forestry and the various professional and personal service industries. In the upper portion of Table 4, the rates of increase since 1885 of 'all' series are summarized according to various resource groups of industries. Taken by itself, this summary is of doubtful meaning, because the production series differ very considerably in the degree of generality of their industrial reference and in the significance of

Table 4

FREQUENCY DISTRIBUTIONS OF AVERAGE RATES OF GROWTH DURING 1885–1929, FOR 'ALL' SERIES AND BASIC SERIES, BY INDUSTRIAL GROUPS

Average annual rate of growth (per cent)	Agriculture and fisheries	Mining	Manufactures and construction	Transportation and trade	All industries
			'All' series		
−5.0 to −3.1	1	..	..	..	1
−3.0 to −1.1	1	2	..	1	4
−1.0 to 0.9	4	1	4	..	9
1.0 to 2.9	13	2	12	2	29
3.0 to 4.9	1	5	17	5	28
5.0 to 6.9	1	4	6	4	15
7.0 to 8.9	1	4	2	..	7
9.0 to 10.9	..	..	2	..	2
11.0 to 12.9	..	..	..	..	..
13.0 to 14.9	..	..	..	..	..
15.0 to 16.9	1	..	..	..	1
17.0 to 18.9	..	1	..	..	1
19.0 to 20.9	..	..	..	..	..
21.0 to 22.9	..	..	..	..	..
23.0 to 24.9	..	1	1	..	2
Total	23	20	44	12	99
			Basic series		
−1.0 to 0.9	2	1	..	..	3
1.0 to 2.9	10	2	7	1	20
3.0 to 4.9	1	4	13	5	23
5.0 to 6.9	..	3	4	1	8
7.0 to 8.9	..	2	2	..	4
9.0 to 10.9	..	..	1	..	1
Total	13	12	27	7	59

their industrial coverage. For this reason, the summary is restricted in the lower portion of the table to 59 basic series,[6]

[6] Though the criterion of basicity was not formulated in precise terms, the points are few at which doubts are likely to arise as to the propriety of the

Table 5

RATES OF GROWTH OF INDUSTRIES: AGRICULTURE AND FISHERIES

(Unit: one per cent)

Group and series	Period covered by series	Average annual rate of growth	
		In period covered	1885–1929
Agriculture			
FOOD CROPS			
Beet sugar	1870–1929	16.0	16.8
Raisins	1872–1929	15.9	8.1
Rice	1870–1929	5.0	5.0
Potatoes	1870–1929	2.1	1.7
Rye	1870–1929	2.0	1.5
Wheat	1870–1930	1.5	1.1
Molasses and sirup	1870–1929	2.0	1.0
Buckwheat	1870–1929	0.5	−0.1
Cane sugar	1870–1929	1.0	−0.6
FEED CROPS			
Barley	1870–1929	4.0	3.4
Oats	1870–1930	2.8	1.6
Hay	1870–1930	2.0	1.2
Corn	1870–1929	1.6	0.9
INDUSTRIAL CROPS			
Tobacco, raw	1870–1929	2.7	2.4
Flaxseed	1879–1929	2.2	2.0
Cotton	1870–1929	2.6	1.9
ANIMAL PRODUCTS			
Cattle	1880–1929	3.0	2.4
Sheep	1880–1929	2.5	2.4
Hogs	1880–1929	2.4	2.3
Wool	1870–1929	1.3	0.3
Fisheries			
Fish, total	1880–1929	0.9	1.0
Cod and mackerel	1870–1929	−1.7	−1.9
Whale	1870–1929	−4.2	−3.7

these constituting a relatively homogeneous group. Average rates of increase of each of the production series are presented in Tables 5–8 according to the industrial divisions of Table 4 and also various subdivisions.[7] These average rates serve to indicate, first, certain major shifts in the structure of the several industrial groups, and second, shifts in the relative importance of these groups in the total production system.

The one common feature of the several industrial groups is the very much smaller degree of divergence of production trends among basic than non-basic industries. Since the rates of advance of the basic series are at a medium level, the extremes on the growth scale of the 'all' series group are obviously accounted for by non-basic series. At the upper end of the growth scale are found such industries as beet sugar, raisins, sulphur, Portland cement, aluminum, and cigarettes—all of which are relatively new industries. At the lower end of the growth scale are found such industries as cane sugar, whaling, mercury, non-Portland cements, and roofing slate—all of which are relatively old industries.

Within the several industrial divisions, the divergence of production trends is rather moderate in the agriculture and fisheries division, but very extensive in the divisions of mining, manufactures and construction, and transportation and trade. Since the outstanding agricultural staples show a fair degree of similarity in their rates of growth, a goodly portion of the shifts in agriculture is traceable to the introduction of

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classification; see, however, p. 183, note 10. The judgment was made with reference to the period covered rather than the present. With minor exceptions, the basic series are drawn from the 'all' series group. The 59 basic series—they are listed in Appendix A, Table 46, column *f*—will be referred to as the basic series group without further qualification.

[7] In view of the method used in determining the decade rates (see pp. 39–41), the measures refer to, but are not always based exactly on, the periods stated in the tables. This holds for all other tables as well.

Table 6

RATES OF GROWTH OF INDUSTRIES: MINING

(Unit: one per cent)

Group and series	Period covered by series	Average annual rate of growth	
		In period covered	1885–1929
FUELS			
Petroleum	1870–1929	9.0	8.5
Natural gas	1882–1929	8.6	5.1
Bituminous coal	1870–1929	5.4	4.3
Coal, total	1870–1929	4.7	3.7
Anthracite coal	1870–1929	2.2	1.2
INDUSTRIAL METALS			
Zinc	1870–1929	7.4	6.0
Copper	1870–1929	7.5	5.4
Iron ore	1880–1929	4.9	4.4
Lead, domestic	1870–1929	5.5	3.7
PRECIOUS METALS			
Gold	1870–1929	0.4	1.0
Silver	1870–1929	1.8	0.7
BUILDING MATERIALS			
Portland cement	1880–1929	18.8	18.5
Gypsum	1880–1929	8.6	8.7
Cement, total	1880–1929	9.1	8.6
Asphalt	1880–1929	13.4	8.0
Non-Portland cements	1880–1929	0.1	−1.5
CHEMICAL MATERIALS			
Sulphur	1880–1929	22.1	24.6
Fluorspar	1880–1929	7.6	7.4
Phosphate rock	1870–1929	7.4	5.4
Salt	1880–1929	4.8	4.9
Pyrites	1880–1929	5.7	3.3
Mercury	1870–1929	−2.0	−1.7

Table 7

RATES OF GROWTH OF INDUSTRIES: MANUFACTURES AND CONSTRUCTION

(Unit: one per cent)

Group and series	Period covered by series	Average annual rate of growth	
		In period covered	1885–1929
FOODS, FEEDS, AND BEVERAGES			
*Beet sugar	1870–1929	16.0	16.8
Cocoa imports	1870–1929	8.8	8.4
Cottonseed cake and meal	1872–1929	8.9	5.5
Canned corn	1885–1929	4.9	4.9
*Salt	1880–1929	4.8	4.9
Cottonseed oil	1872–1929	8.3	4.7
Canned tomatoes	1885–1929	3.8	3.8
Distilled spirits	1870–1918	2.9	3.3
Fermented liquors	1870–1918	4.4	3.1
Raw sugar consumption	1870–1930	3.4	3.0
Coffee imports	1870–1929	2.8	2.5
*Cattle	1880–1929	3.0	2.4
*Sheep	1880–1929	2.5	2.4
*Hogs	1880–1929	2.4	2.3
Flour	1880–1929	1.3	1.1
*Cane sugar	1870–1929	1.0	–0.6
TOBACCO PRODUCTS			
Cigarettes	1880–1929	11.6	10.5
Tobacco consumption	1880–1929	2.5	2.3
Tobacco and snuff	1871–1929	2.3	1.4
Cigars	1880–1929	1.6	1.3
TEXTILE PRODUCTS			
Silk imports, raw	1870–1929	8.0	6.9
Silk imports, unmanufactured	1883–1929	6.8	6.8
Cotton consumption	1870–1929	3.5	3.0
Sisal imports	1870–1929	6.3	2.9
Manila hemp imports	1870–1929	2.1	2.1
Minor fiber imports	1870–1929	2.7	1.1
Wool consumption	1870–1930	1.7	1.0
Jute imports	1870–1929	1.3	–0.6

Table 7 (cont.)

RATES OF GROWTH OF INDUSTRIES: MANUFACTURES AND CONSTRUCTION

(Unit: one per cent)

Group and series	Period covered by series	Average annual rate of growth	
		In period covered	1885–1929
IRON, STEEL, AND COKE			
Steel	1870–1929	10.4	7.2
Rolled iron and steel	1885–1929	5.0	5.0
Coke	1880–1929	5.4	4.6
Pig iron	1870–1929	5.4	4.4
NONFERROUS INDUSTRIAL METALS AND THEIR PRODUCTS			
Aluminum	1883–1929	24.3	24.3
*Zinc	1870–1929	7.4	6.0
Copper consumption	1883–1929	6.0	6.0
Zinc consumption	1873–1929	6.5	5.8
*Copper	1870–1929	7.5	5.4
Tin-plate consumption	1871–1929	5.6	4.4
Antimonial lead	1871–1929	6.9	4.3
Lead, total	1870–1929	5.7	4.1
Tin imports	1870–1929	5.0	4.1
Lead consumption	1870–1929	3.9	3.7
PRECIOUS METALS AND THEIR PRODUCTS			
Silver consumption	1880–1929	5.1	4.8
Gold consumption	1880–1929	3.6	3.4
*Gold	1870–1929	0.4	1.0
*Silver	1870–1929	1.8	0.7
BUILDING MATERIALS AND CONSTRUCTION			
*Portland cement	1880–1929	18.8	18.5
*Cement, total	1880–1929	9.1	8.6
Flaxseed consumption	1879–1929	3.3	3.2
Building permits	1874–1929	4.2	2.6
White lead	1884–1929	1.8	1.8
Rails	1870–1929	2.3	1.4
Nails	1872–1929	2.2	1.3
Rail consumption	1870–1929	1.5	1.0

Table 7 (cont.)

RATES OF GROWTH OF INDUSTRIES: MANUFACTURES AND CONSTRUCTION

(Unit: one per cent)

Group and series	Period covered by series	Average annual rate of growth	
		In period covered	1885–1929
Roofing slate	1879–1929	0.0	−0.8
*Non-Portland cements	1880–1929	0.1	−1.5
TRANSPORTATION EQUIPMENT			
Vessels	1870–1929	−0.2	0.5
Locomotives	1880–1929	0.0	−0.1
MISCELLANEOUS			
Rubber imports	1870–1929	8.5	9.1
Superphosphate	1870–1929	6.8	5.0

*These series are repeated from Tables 5–6.

new crops, such as sugar beets, raisins, and various vegetables, and to the decline of pasture, as reflected in the trend of wool production. In contrast to the agricultural industries, the minerals evidence very considerable variability. The series of manufactures resemble the minerals in the striking diversity of their rates of advance. Their variability would doubtless be appreciably greater if the list of series contained a larger number of specific and minor commodities; for "a growing share of our manufacturing product now consists of unessentials—man's toys and playthings," the demand for which is "determined largely by fashion and caprice." [8] Finally, though the transportation and trade series show only a moderate degree of divergence in their trends, the shifts in the pattern

[8] V. S. Clark, *History of Manufactures in the United States, 1860–1914* (Carnegie Institution of Washington, Publication No. 215B, Vol. II, 1928), p. 836.

Table 8

RATES OF GROWTH OF INDUSTRIES: TRANSPORTATION AND TRADE

(Unit: one per cent)

Series	Period covered by series	Average annual rate of growth	
		In period covered	1885–1929
Transportation			
S. S. Marie canals traffic	1870–1929	8.9	6.9
Postage stamps	1870–1929	6.3	6.6
Postal money orders	1870–1929	7.9	6.5
Railway ton-miles	1870–1929	6.0	4.9
Railway passenger-miles	1882–1929	3.5	3.2
Coastal trade	1870–1929	2.2	2.7
N. Y. canals traffic	1870–1929	−1.1	−1.3
Trade			
Shares traded	1875–1929	5.0	5.7
Deflated clearings	1870–1929	5.2	4.6
Railway freight	1882–1929	4.3	3.9
Tonnage entered and cleared	1870–1929	3.5	3.8
Agricultural exports	1870–1929	2.0	1.0

of this industrial division have, as a matter of fact, been very extensive. One reason why they are not disclosed adequately is that certain new transport agencies,—the telephone, wireless, automobile, pipe line, and airplane,—which have grown at extremely rapid rates, are not covered in our list of series. Another reason is that most of the series in the trade and transportation group are of exceptionally broad industrial scope.[9]

A close inspection of Tables 4–8 will suggest, and additional evidence is presented in Chapter VI, that the various

[9] Concerning defects in the original series, which are reflected in the measures of their average rates of growth, see Appendix C, I.

major industrial groups have themselves grown at widely unequal rates.[10] Among the major branches of commodity production, mining has grown at a spectacular rate, manufacture at a somewhat lower rate, and agriculture at a decidedly lower rate. Some fifty to sixty years ago, agriculture was dominant, mining of relative insignificance, and manufactures were only beginning to step into their stride. At present, the elaborative industries are the dominating form of economic activity, and the mineral industries occupy the key position in our mechanized industrial system. The only other industrial groups covered in this survey are the fisheries, transportation, and trade. Though the fisheries industry has been mildly progressive, it has declined sharply in relative importance. Transportation and trade have increased in relative importance. As for forestry and the various personal service industries, which are not included in our survey, the former has declined in relative importance, while the relative trend of the latter has increased.

2. Causes of Divergence

Of late, a number of economists, most notably Cassel, have explicated the notion of a progressive economy, characterized by a rate of advance constant over time and uniform for all goods and agents of production including population. Whatever the merits of this conception may be for some problems in economic theory, it is certainly misleading to term such a hypothetical economy 'progressive'. For when all intercommodity relations of sequence, complementariness, and joint production are assumed to be constant, as is the number and kind of commodities, and the responsiveness of nature to man's

[10] See pp. 264–8. See also P. K. Whelpton, "Occupational Groups in the United States, 1820–1920," *Journal of the American Statistical Association*, September, 1926; A. R. Eckler, "Occupational Changes in the United States, 1850–1920," *Review of Economic Statistics*, May, 1930; and R. G. Hurlin and M. B. Givens, "Shifting Occupational Patterns" (Ch. VI of *Recent Social Trends in the United States*, Vol. I, McGraw-Hill, 1933).

efforts, practically everything 'progressive' is omitted from the economy so termed. Industrial changes which we consider 'progressive' comprise revisions of productive techniques, conservation in the use of raw materials, changes in the number and kind of commodities produced, and so on. Such changes take place incessantly, and as their impact on various industries is unequal, they lead to divergent production trends. A progressive economy is always characterized by differences in the rates of development of its individual industries.

The very causes which have determined the rapid advance of general production in this country since the Civil War have also determined the divergence in the trends of its separate industries. Progress in the general economy has been marked by the invention of new commodities, development of new raw materials, and discovery of new mineral resources; by changes in the methods of production, transformation of industrial equipment, recovery of waste products, and changes in the forms of industrial organization; by an increase in the number of uses to which given raw materials are put, and in the number of materials put to given uses; and by an emergence of a variety of luxury products and style goods. These changes have resulted in an increasing divergence of production trends, for they have served to stimulate or depress, but to an unequal extent, the development of the various industries. Taking the economic system as a whole, the consequence has been that intercommodity relations of sequence, complementariness, and joint production have tended to become increasingly flexible; or to put it differently, those technical relations among commodities which make for similarity in rates of industrial growth have tended to diminish in importance.

The rates of industrial growth presented in Tables 5–8 illustrate abundantly the results of progressive developments, the differential extent of these developments in the various

industries, and the impact of changes in the outside economy —all of which have made for divergence of production trends and, consequently, for shifts in the pattern of our national industry. For example, the trend towards more effective working of natural deposits is reflected in the rapid growth of the sulphur, copper, and petroleum industries; the trend towards increasing reclamation of waste products, in the rapid growth of the cottonseed products industries; towards reuse of materials, in the more rapid advance of steel than pig iron; towards better utilization of materials, in the respective rates of advance of feed crops and meat products; [11] towards increasing roundaboutness in the methods of production, in the generally more rapid growth of producers' goods than consumers' goods industries; towards improvement in agricultural technique, in the rapid growth of the phosphate industries; towards improvement in the quality of production, in the downward trend of the number of locomotives manufactured; and towards industrial diversification, in the sharp contrast between the rates of growth of such commodities as Portland and non-Portland cements, petroleum and coal, and cigarettes and other tobacco products. The resistance of nature to progressive developments is reflected conspicuously in the trends of the whaling, mercury, gold, and anthracite coal industries. The impact of changes in the outside economy on the de-

[11] The rates of increase of the animal slaughter series are higher than the rates of growth of any of the feed crops except barley, which is not a feed crop of outstanding importance. This contrast is more striking in the light of the decline in pasture acreage, which averaged 3 million acres per year between 1880 and 1920 (*Yearbook of Agriculture*, 1923, p. 317). A large portion of the difference between the two groups of series is accounted for by the defective statistical constitution of the animal slaughter series (see Appendix C, I). But several economic factors have conduced to the difference: the increasing efficiency of animals in converting feed into live weight, the recent decline in the population of work animals, the declining use of the so-called feed crops for purposes of human consumption, and the rapid growth of several minor feed crops (not included in Table 5) and certain manufactured feeds. Probably, the net exports of feed crops have also tended to decline relative to their total output (see p. 149).

velopment of domestic industries is reflected, for example, in the trend of jute imports, and in the discrepancy between the rates of production and consumption of wool, flaxseed, cotton, and copper. Finally, the growth of general welfare and change in methods of living are reflected in the sharp rates of advance of silk,[12] rubber, and cocoa imports, in the higher rate of growth of the sugar than the flour industry, and in the rapid advance of canned foodstuffs. Considerable divergence of production trends is, then, one of the essential features of a progressive economy. The more rapid the rate of general progress, the greater is the divergence of individual production trends likely to be; and some statistical evidence is presented later to show that the divergence of production trends has actually varied with the degree of progressiveness of our economy.[13]

Sharp discrepancies among rates of industrial growth are not, however, characteristic of a progressive economic system alone; they may also be found in a retrogressive economy. What distinguishes a progressive from a retrogressive system is the type of skewness, not the dispersion, of a distribution of rates of industrial change. In a progressive economy, as we know it, new industries are continually started, and occasionally, old industries are rejuvenated. The rate of growth of such industries is, generally, excitingly rapid; and this factor, quite apart from others working in the same direction, tends to produce a decided 'positive' skewness. When the rates of industrial growth are skewed towards the higher values, the indications are that the forces making for growth in the eco-

[12] It must be noted that our series of silk imports, though fair indicators of the growth of the domestic silk manufacture, cannot be used to indicate the trend in domestic consumption of silk products. While imports of manufactured silk are at present dwarfed by the domestic output, such imports were much more extensive than the domestic output during the 'seventies. See F. W. Taussig, *Some Aspects of the Tariff Question* (3d ed., Harvard University Press, 1931), pp. 221, 408.

[13] See pp. 242–3.

nomic system are in the ascendent over the forces making for decline. In a retrogressive economy, on the other hand, there will be few industries growing at a rapid rate, but many will be declining, a number of them at a rapid rate, and some —perhaps the pivotal ones exercising a downward pull on the system—at a very rapid rate. A distribution of rates of industrial change will therefore tend to be skewed 'negatively' in a retrogressive economy; and the skewness towards the lower values will reflect the dominance of the forces making for decline in the system over the forces making for growth. Despite their restricted industrial scope, the frequency distributions of Chart 1 show definitely a positive skewness. While they do not (and could not) reveal accurately the specific outlines of an ensemble of the rates of growth of all industries, they possess that general form which one would anticipate a priori.[14]

We noted in our statistical survey that the primary trends of production (as expressed in long-range average rates of growth) of basic industries are less divergent than of non-basic industries, and of agricultural industries than of min-

[14] The analysis would not be changed materially for weighted frequency distributions of rates of industrial change, weights being assigned to the various industries according to some index of their importance; for, the importance of industries is correlated with their rates of growth, the more important industries being characterized by medial rates of growth, and the less important by extreme rates. If anything, the degree of 'positive' skewness would probably be somewhat accentuated in the case of a weighted frequency distribution of rates of industrial change in a progressive economy; for there is some tendency for industries with extremely high rates of growth to be, on the whole, of greater importance than industries with extremely low rates of (algebraic) growth. The opposite is probably true of a retrogressive economy. It should be carefully noted, however, that our various statements concerning a retrogressive economy proceed on the implicit assumption that, since retrogression is the opposite of progress, a frequency distribution of rates of industrial change in a retrogressive economy will be the antithesis of a distribution for a progressive economy—a plausible assumption, to be sure, but one which might easily be invalid, if only because our knowledge of a progressive economy is confined to what may be merely a single type of progressive economy, and our knowledge of even that is not very great. See Ch. IV, sec. III, 1.

erals or manufactures. The smaller divergence of the production trends of basic than of non-basic industries derives, in part, from the closer technical ties uniting them, and in part, from their considerable size, which makes sharp rates of advance or decline unlikely. The rather moderate divergence of production trends in agriculture is due chiefly to the gradualness of change in the relative demand for agricultural products, itself a result in large part of the considerable extent to which they are substitutive in production and consumption; but it is due also to the interlocked character of much of agricultural production, as of feed crops and animal products, and to the similarity of foreign influences on individual agricultural industries, especially the various food products. The considerably greater divergence of production trends in the mining and manufacturing industries is due principally to the fact that their products serve, on the whole, more distinctive uses than do those of agriculture; that mineral products and manufactures, especially the latter, are subject to sharper changes in consumption habits, when long periods are considered; that they reflect the increasing roundaboutness and mechanization of all industry, including agriculture; and that their productive resources, especially in mining, while varying widely in quality, are highly specialized and so do not admit of the mobility possible in agriculture.

But these several divisions of commodity production have themselves grown at unequal rates. This is traceable to differences in the type of demand for, and in the comparative advantage of this country in the production of, their respective products. As agriculture yields mainly foodstuffs and textile materials, the demand for which is fairly inelastic, its output has tended to grow at a rate not very much faster than population. The growth of manufactures has been much greater, since the increasing prosperity of the nation has expressed itself in increasing wants for and increasing variety of

elaborative products. The rapid growth of manufacture and transportation and their increasing mechanization have served to make the rate of growth of the mining industry exceed that of the other branches of commodity production.

However, the changing comparative advantage of the United States in the production of agricultural and nonagricultural commodities has been, perhaps, of even greater importance than the difference in the conditions underlying the demand for these two classes of products. Between the close of the Civil War and the turn of the century, our agriculture expanded at a rapid rate, while agricultural exports were so extensive that the United States came to be known as the 'granary of Europe'. But beginning with 1900 or so, our export of foodstuffs has declined steadily, except for the War and immediate post-War years; and though our export of cotton and tobacco continued to increase after that date, the advance has been relatively small. As a nation we might of course have continued after the turn of the century to devote our industrial energies to agriculture in relatively the same degree as formerly, utilize our surplus productive powers in the feeding of other nations, and obtain in return a variety of manufactures. This did not happen because we found it more advantageous to devote an increasing portion of our energies to nonagricultural pursuits. On the one side, mechanized industry was making tremendous headway in the United States. Our mineral resources were exploited energetically, if only for the reason that "in no other country can the mineral raw materials as a whole be delivered to manufacturing industry at lower prices." [15] And as increasing progress was made in the standardization, mechanization, and mass production of commodities, the United States ad-

[15] F. G. Tryon and L. Mann, "Mineral Resources for Future Populations" (Ch. VIII of *Population Problems in the United States and Canada*, ed. by L. I. Dublin; Pollak Foundation for Economic Research, 1926), p. 112.

vanced to the front rank among manufacturing nations. On the other side, the agricultural map of the world was changing. While the decline in virgin lands was beginning to revise agricultural costs in this country, certain other regions which were experiencing the first flush of agricultural expansion—Argentina, Australia, Canada, Russia, and India—were offering severe competition to our products in foreign markets. The changing position of the United States in the production of agricultural commodities was reflected, during the decade or two before the World War, in a relative rise of agricultural prices with respect to both manufactures in this country and agricultural commodities abroad.[16]

II. INCONSTANCY OF RATES OF GROWTH

Changes in the pattern of national industry are disclosed in only the most general way by a set of long-term average rates of growth. Such rates imply trends of production of a simple exponential type; but as a matter of fact, few industries have traced out such trends over the past half-century or so.[17] They imply further that the relations among industrial trends have changed in a constant manner, but these relations have actually been inconstant from decade to decade. They might be interpreted to mean that industries having the same average rates of growth have also the same secular trends, but identical averages at times result from widely differing secular trends. Not only has the pattern of production undergone tremendous shifts, but these shifts themselves have not followed any simple plan. Or to put it differently, marked variations in the rates of growth of given industries over time have been superadded to differences in rates of industrial growth at any one time.

A glimpse into the inconstancy of the rates of growth of

[16] See pp. 149–50, and E. G. Nourse, *American Agriculture and the European Market* (McGraw-Hill, 1924), Ch. I and Appendix B.

[17] See p. 36, note 6.

Table 9

MEASURES OF INCONSTANCY OF GROWTH OF INDUSTRIES

Series	Period covered by series	Standard deviation of decade rates	Range of decade rates	Measure of continuity of growth
		(Unit: one per cent)		
Agriculture and fisheries				
Beet sugar	1870–1929	14.4	49.3	1.00
Raisins	1872–1929	14.2	37.5	1.00
Rice	1870–1929	5.1	19.1	.82
Cane sugar	1870–1929	5.1	17.1	.27
Flaxseed	1879–1929	5.1	15.1	.33
Rye	1870–1929	4.3	18.9	.82
Whale	1870–1929	3.9	15.2	−.82
Molasses and sirup	1870–1929	3.9	13.1	.64
Barley	1870–1929	2.8	10.1	.82
Cattle	1880–1929	2.8	8.5	.78
Oats	1870–1930	2.4	7.7	.64
Sheep	1880–1929	2.3	8.3	.78
Cotton	1870–1929	2.2	7.9	.64
Tobacco, raw	1870–1929	2.2	7.1	.82
Buckwheat	1870–1929	2.1	7.2	.36
Wool	1870–1929	2.1	6.8	.36
Hay	1870–1930	1.8	7.0	.64
Corn	1870–1929	1.8	6.5	.64
Cod and mackerel	1870–1929	1.7	6.4	−.55
Wheat	1870–1930	1.7	6.3	.64
Potatoes	1870–1929	1.5	4.8	.64
Hogs	1880–1929	1.0	3.7	1.00
Fish, total	1880–1929	0.8	2.9	.67
Mining				
Sulphur	1880–1929	31.8	108.4	1.00
Asphalt	1880–1929	18.0	58.6	.56
Portland cement	1880–1929	14.0	43.9	1.00
Non-Portland cements	1880–1929	11.5	35.5	.11
Natural gas	1882–1929	10.8	40.8	.78
Pyrites	1880–1929	8.6	35.3	.78
Fluorspar	1880–1929	7.6	28.4	.56

Table 9 (cont.)

MEASURES OF INCONSTANCY OF GROWTH OF INDUSTRIES

Series	Period covered by series	Standard deviation of decade rates	Range of decade rates	Measure of continuity of growth
		(Unit: one per cent)		
Mining (cont.)				
Mercury	1870–1929	6.7	24.7	−.09
Gypsum	1880–1929	5.4	18.9	1.00
Gold	1870–1929	4.8	18.4	−.09
Copper	1870–1929	4.8	18.1	.82
Phosphate rock	1870–1929	4.7	16.3	.82
Cement, total	1880–1929	4.6	16.0	1.00
Lead, domestic	1870–1929	4.1	15.2	1.00
Zinc	1870–1929	3.6	14.8	.82
Petroleum	1870–1929	3.6	14.5	1.00
Iron ore	1880–1929	3.5	12.7	.78
Bituminous coal	1870–1929	3.5	12.5	.91
Coal, total	1870–1929	3.0	10.7	.64
Anthracite coal	1870–1929	2.6	9.7	.64
Silver	1870–1929	2.3	6.8	.36
Salt	1880–1929	2.2	7.0	1.00
Manufactures and construction				
Aluminum	1883–1929	21.3	64.5	1.00
Vessels	1870–1929	16.8	76.8	−.09
Locomotives	1880–1929	7.5	29.2	.33
Sisal imports	1870–1929	7.5	27.3	.64
Steel	1870–1929	7.3	29.1	1.00
Cottonseed oil	1872–1929	7.2	23.0	.82
Antimonial lead	1871–1929	7.0	29.0	.82
Cottonseed cake and meal	1872–1929	7.0	23.8	.82
Cigarettes	1880–1929	6.5	20.6	.78
Building permits	1874–1929	6.0	20.8	.40
Rubber imports	1870–1929	5.6	20.3	1.00
Roofing slate	1879–1929	5.1	16.4	.11
Superphosphate	1870–1929	4.5	16.0	1.00
Lead, total	1870–1929	4.1	15.2	1.00
Rail consumption	1870–1929	4.1	14.4	.45

Table 9 (cont.)

MEASURES OF INCONSTANCY OF GROWTH OF INDUSTRIES

Series	Period covered by series	Standard deviation of decade rates	Range of decade rates	Measure of continuity of growth
		(Unit: one per cent)		
Manufactures and construction (cont.)				
Canned corn	1885–1929	3.6	12.1	1.00
Jute imports	1870–1929	3.6	11.9	.09
Rails	1870–1929	3.5	12.4	.45
Coke	1880–1929	3.5	11.6	.78
Minor fiber imports	1870–1929	3.4	12.6	.64
Gold consumption	1880–1929	3.3	11.8	.78
Silver consumption	1880–1929	3.3	10.8	1.00
Canned tomatoes	1885–1929	3.0	9.7	.75
Cocoa imports	1870–1929	2.9	9.5	1.00
Pig iron	1870–1929	2.8	9.5	.82
Copper consumption	1883–1929	2.7	9.9	1.00
Rolled iron and steel	1885–1929	2.7	9.6	1.00
Tin-plate consumption	1871–1929	2.5	9.5	1.00
Fermented liquors	1870–1918	2.5	8.5	.78
Zinc consumption	1873–1929	2.5	8.4	1.00
Flaxseed consumption	1879–1929	2.4	7.6	.78
Distilled spirits	1870–1918	2.3	8.6	.78
Silk imports, raw	1870–1929	2.2	7.3	1.00
Cigars	1880–1929	2.2	7.3	.56
Tin imports	1870–1929	2.2	6.4	1.00
Wool consumption	1870–1930	2.1	8.4	.82
Nails	1872–1929	2.1	7.2	.73
Tobacco and snuff	1871–1929	2.1	7.0	.64
Manila hemp imports	1870–1929	2.0	8.1	.82
White lead	1884–1929	1.9	5.1	.50
Coffee imports	1870–1929	1.7	5.5	1.00
Cotton consumption	1870–1929	1.5	5.4	.91
Silk imports, unmanufactured	1883–1929	1.3	4.2	1.00
Raw sugar consumption	1870–1930	1.2	3.7	1.00
Lead consumption	1870–1929	1.1	4.0	1.00
Tobacco consumption	1880–1929	1.0	3.1	1.00
Flour	1880–1929	1.0	3.0	.78

Table 9 (cont.)

MEASURES OF INCONSTANCY OF GROWTH OF INDUSTRIES

Series	Period covered by series	Standard deviation of decade rates	Range of decade rates	Measure of continuity of growth
		(Unit: one per cent)		
Transportation and trade				
Shares traded	1875–1929	8.6	30.3	.40
S. S. Marie canals traffic	1870–1929	6.2	20.9	.82
N. Y. canals traffic	1870–1929	4.7	19.5	−.45
Agricultural exports	1870–1929	3.1	11.7	.45
Railway passenger-miles	1882–1929	3.1	10.3	.78
Railway ton-miles	1870–1929	2.7	9.2	1.00
Postal money orders	1870–1929	2.7	8.2	1.00
Railway freight	1882–1929	2.4	7.3	1.00
Coastal trade	1870–1929	1.8	5.2	.64
Tonnage entered and cleared	1870–1929	1.6	5.8	.82
Deflated clearings	1870–1929	1.5	4.7	1.00
Postage stamps	1870–1929	1.0	3.8	1.00

individual industries may be obtained by comparing their rates of advance, detailed in Tables 5–8, during the period 1885–1929 and such longer periods as are covered by the statistical records. It will be noticed that the two rates for each series are practically never identical, and that the differential between them varies considerably. A far more comprehensive view of the extent of the inconstancy in the rates of growth of the various industries is afforded by Table 9, which presents three measures of inconstancy of growth for each series. The first measure is the standard deviation of the decade rates, and thus measures the 'average' extent of the variation of the decade rates of a given series.[18] The second

[18] When the standard deviation (or average deviation) of the decade rates is measured from their mean, the degree of uniformity in the 'slope' of the secular trend is ascertained with reference to the 'slope' of a primary trend of the type of a simple exponential curve. The chief ground for preferring the

measure states the range of the decade rates, that is, the difference between the highest and lowest of the decade rates of a given series. The third is a measure of the continuity of growth; it expresses the excess of the number of positive over negative decade rates of a given series as a ratio to the number of its decade rates.[19] This measure has a theoretical range from + 1 to − 1: the limits indicate respectively that growth has been continuous throughout in the sense that the trend has been upward in each decade, and that decline has been continuous throughout in the sense that the trend has been downward in each decade. The three measures are designed to reveal different aspects of the inconstancy in the trend movements of given industries over time. The measures relate to such periods as the series cover.[20]

The measures of continuity of growth for the ensemble of series are summarized in Table 10.[21] Being positive and high for the most part, they bear witness to the strong

standard deviation to the average deviation is that variability is later measured also from a line defining the drift of the decade rates (see Ch. V, sec. IV); in such a case the standard deviation does, while the average deviation does not, insure formally consistent results, in the sense that the variability about a 'trend line' must be lower than or equal to the variability about the arithmetic mean.

It is frequently argued that the standard deviation gives a larger weight to extreme items than the average deviation. Apparently, this criticism means (otherwise it seems pointless) that the average deviation of a given series containing an extreme item in relation to the others, will differ by a smaller percentage from the average deviation of the given series with the extreme item excluded, than would the standard deviation of the given series containing the extreme item from the standard deviation of the series with the extreme item excluded. But no such general mathematical rule can be proved.

[19] Decade rates of zero were ignored in determining the numerator of the ratio; this is tantamount to counting zeroes as half-positive and half-negative.

[20] The comparability of the ranges and also of the standard deviations of the decade rates, as among the various series, is impaired somewhat by the non-uniformity of their periods; for, as Chapter IV shows, retardation in industrial growth has been a systematically operative factor.

[21] Concerning the composition of the several groups of series in Tables 10–12, see p. 52, note, and p. 56, note 6. The group of nonagricultural industries in Table 10 excludes both agricultural and fisheries series.

Table 10

FREQUENCY DISTRIBUTIONS OF MEASURES OF CONTINUITY OF GROWTH, FOR 'ALL' SERIES AND BASIC SERIES, BY INDUSTRIAL GROUPS

Measure of continuity of growth	Agriculture and fisheries (1)	Nonagricultural industries (2)	All industries (1) + (2)
	'All' series		
−.99 to −.80	1	..	1
−.79 to −.60	..	..	..
−.59 to −.40	1	1	2
−.39 to −.20	..	..	..
−.19 to .00	..	3	3
.01 to .20	..	3	3
.21 to .40	4	4	8
.41 to .60	..	7	7
.61 to .80	10	17	27
.81 to 1.00	7	41	48
Total	23	76	99
Below 1.00	20	48	68
1.00	3	28	31
Total	23	76	99
	Basic series		
−.19 to .00	..	1	1
.01 to .20	..	..	..
.21 to .40	1	2	3
.41 to .60	..	1	1
.61 to .80	9	11	20
.81 to 1.00	3	31	34
Total	13	46	59
Below 1.00	12	24	36
1.00	1	22	23
Total	13	46	59

secular forces of progressiveness which have been operating in the economy. As might be expected, the measures of continuity of growth of industries are fairly closely correlated with their average rates of growth. But even the industries which have grown at an exceptionally rapid rate do not always evidence perfect continuity of growth. This is true especially of industries which fall outside of the 'basic' category; for when large stocks are customary, as in fluorspar, or foreign competition is considerable, as in pyrites, or another and more important industry shares in the market, as is the case of native asphalt which is dwarfed by manufactured asphalt, secular trends are likely to be sharply undulatory. Though non-basic series account for a relatively greater proportion of the measures of continuity which fall short of unity than do basic series, it is yet worth noting that less than 40 per cent of the basic series have experienced an uninterrupted upward secular movement. It is also of some significance that agricultural series have, on the average, somewhat lower measures of continuity than the nonagricultural; only three agricultural industries—beet sugar, raisins, and hog production—have had consistently an upward trend.

The measure of continuity of growth takes cognizance of the signs of the decade rates, but not of their absolute magnitudes. It therefore serves to reveal the degree of uniformity in the type of direction of the secular trend of a series, but not the degree of uniformity in the 'slope' of the secular trend. Series having given measures of continuity of growth may and do differ considerably from the standpoint of the variability of their decade rates. And the presence of some series with measures of continuity of 1.00 among those evidencing the extremest variability in their decade rates indicates that the measures of continuity may understate the degree of inconstancy in the secular movements of industries over

Table 11

FREQUENCY DISTRIBUTION OF RANGES OF DECADE RATES, FOR 'ALL' SERIES

Range of decade rates (per cent)	Number of series
2.0 to 4.9	9
5.0 to 7.9	22
8.0 to 10.9	19
11.0 to 13.9	9
14.0 to 16.9	10
17.0 to 19.9	7
20.0 to 22.9	4
23.0 to 25.9	3
26.0 to 28.9	2
29.0 to 31.9	4
32.0 to 34.9	..
35.0 to 37.9	3
38.0 to 40.9	1
41.0 to 43.9	1
44.0 to 46.9	..
47.0 and over *	5
Total	99

* The items in this class are: 49.3, 58.6, 64.5, 76.8, and 108.4.

time. The range depicts that inconstancy most graphically, the standard deviation with greater fidelity to the individual decade rates. A general summary of the ranges is given in Table 11, and a detailed analytic summary of the standard deviations in Table 12.

The outstanding features of the measures of variability of decade rates consist in the large difference among them and their generally high level. The smallest of the ranges is 2.9 per cent for fish, and the largest over 100 per cent for sulphur. About half of the series have ranges of over 11 per cent, about a quarter over 20 per cent, and about a tenth over 35 per cent. The standard deviations are closely

Table 12

FREQUENCY DISTRIBUTIONS OF STANDARD DEVIATIONS OF DECADE RATES, FOR 'ALL' SERIES AND BASIC SERIES, BY INDUSTRIAL GROUPS

Standard deviation of decade rates (per cent)	Agriculture and fisheries	Mining	Manufactures and construction	Transportation and trade	All industries
			'All' series		
0.0 to 0.9	1	..	..	..	1
1.0 to 1.9	6	..	7	4	17
2.0 to 2.9	8	3	15	3	29
3.0 to 3.9	2	4	7	2	15
4.0 to 4.9	1	4	3	1	9
5.0 to 5.9	3	1	2	..	6
6.0 to 6.9	..	1	2	1	4
7.0 to 7.9	..	1	6	..	7
8.0 to 8.9	..	1	..	1	2
9.0 to 9.9	..	..	..	..	..
10.0 to 10.9	..	1	..	..	1
11.0 to 11.9	..	1	..	..	1
12.0 to 12.9	..	..	..	..	..
13.0 to 13.9	..	..	..	..	..
14.0 to 14.9	2	1	..	..	3
15.0 and over *	..	2	2	..	4
Total	23	20	44	12	99
			Basic series		
0.0 to 0.9	1	..	..	..	1
1.0 to 1.9	5	..	7	4	16
2.0 to 2.9	7	3	11	2	23
3.0 to 3.9	..	4	4	1	9
4.0 to 4.9	..	5	1	..	6
5.0 to 5.9	..	..	1	..	1
6.0 to 6.9	..	..	1	..	1
7.0 to 7.9	..	..	2	..	2
Total	13	12	27	7	59

* The items in this class are: mining, 18.0 and 31.8 per cent; manufactures and construction, 16.8 and 21.3 per cent.

correlated with the ranges. About half are above 3 per cent, and about a tenth above 10 per cent. The largest of the standard deviations are accounted for by non-basic series, and the standard deviations of the agricultural series are generally lower than of the nonagricultural. These industrial differences correspond to those which were found to hold for average rates of growth.[22]

III. ELEMENTS OF ORDER IN SECULAR CHANGE

The inconstancy in the rates of growth of the individual industries over time creates the impression that the secular changes in the pattern of general production have taken place in an irregular and unsystematic manner. But this impression is tempered by the threads of order and continuity which analysis discloses in the maze of industrial changes. Though irregular in large part, the secular shifts in the pattern of national industry have also been systematic to a considerable extent. The remaining portion of this chapter serves to introduce, and the following two chapters attempt to trace in detail, the elements of order in the process of secular change.

We have previously emphasized the irregularity in the differentials between the two average rates of growth given for each series in Tables 5–8, but careful scrutiny of the differentials suggests an underlying similarity in the behavior of the trends of the various industries. Though the differential between the two rates varies from series to series, its direction is on the whole remarkably systematic: all but four of the series of agriculture and fisheries show higher rates of growth when their full statistical history since 1870 is considered than for the period since 1885, and so do all but five

[22] The variability of the decade rates is investigated more thoroughly, though from a different angle, at a later point; see Ch. V, sec. IV.

of the mineral series, all but four series of manufactures and construction, and all but four series of transportation and trade.[23] The systematic direction of the differential indicates that the rates of growth of the industries covered were generally higher during 1870–85 than in the following years, and suggests that dominating causes common to the various industries were operative. Certainly, the class of agricultural industries received a considerable impetus during the period 1870–85 from the liberal homestead policy of the federal government, the westward extension of railroads, and the introduction of new machinery. But the differential in the average rates of growth suggests that other major forces have been at work,—forces which have extended over the entire range of industry and found expression in a declining rate of growth in the generality of individual industries. This is

[23] There are, then, seventeen exceptions in all, two of them—rice production and Manila hemp imports—having the same average rate for each period. Few of the exceptions have much significance. Several series commence as late as 1880; this makes the present comparison inapt. In the case of beet sugar, sulphur, rubber imports, and vessels, peculiar circumstances explain the higher rates of growth during the shorter period. Technological factors were dominant in the beet sugar industry: before 1890 the industry was virtually in an experimental stage, its output being quite negligible (see *Yearbook of Agriculture*, 1923, p. 156). The revolutionary change shortly after 1900 in the technical conditions of the sulphur industry renders almost meaningless any long-term average for this industry (see pp. 156–7). In the case of rubber imports, long-term comparisons are misleading because of the recent advent of the automobile (see pp. 154–5). The present comparison is pointless for vessels, in view of the influence of the extraordinary War-time boom in shipbuilding on its average rate of growth. As for the rice industry (which has the same average rate for the two periods), its underlying mechanism was changed towards the end of the 'eighties by a technical revolution in methods of cultivation; the scope of the transformation can be inferred from the fact that during 1895–1905 rice production expanded at the extraordinary pace of something like 19 per cent per year (see p. 157).

A word may be added about the series for which the same average rates of growth are recorded in the columns 'in period covered' and '1885–1929' (Tables 5–8). Except in the cases of rice production and Manila hemp imports, already mentioned, these averages are based on identical sets of decade rates, the minor differences in the periods stated having no meaning for the present comparison; see pp. 39–41, and p. 56, note 7.

also intimated by Table 13, which shows that extremely high rates of growth occurred with very much greater frequency in the early than in the late decades, and that the number of industries having downward trends has been very much greater in recent than in remote decades.

Table 13

PRODUCTION SERIES HAVING DECADE RATES OF 10 PER CENT OR MORE, AND 0 OR LESS, BY DECADES INDICATED BY THEIR CENTRAL YEARS

Central decade year	Total number of series covered	Rates of 10 per cent or over		Rates of 0 or less	
		Number of series	Percentage of series covered	Number of series	Percentage of series covered
1875	66	16	24.2	6	9.1
1880	69	20	29.0	5	7.2
1885	97	17	17.5	8	8.2
1890	104	11	10.6	10	9.6
1895	104	10	9.6	8	7.7
1900	104	21	20.2	8	7.7
1905	104	8	7.7	11	10.6
1910	104	4	3.8	17	16.3
1915	104	9	8.7	22	21.2
1920	102	5	4.9	43	42.2
1925	102	6	5.9	26	25.5

For the present, these indications concerning the tendency of industries to grow at a declining rate will have to suffice, as this subject is investigated in considerable detail in the next chapter. But it is important to note that insofar as individual industries grow at declining rates, the pattern of production will tend to undergo modification in a somewhat regular manner. If total production grew, for example, at a constant percentage rate while individual industries (their number being fixed or increasing) grew at declining

rates, the percentage contributions of the individual industries to the production aggregate would be steadily diminishing over time, or else increasing but at a diminishing percentage rate.

When we take full account of the decade rates of the series, further evidence emerges of regularity in changes in the pattern of the production system. Table 14 aims to disclose through two measures the degree of stability in the relations of the trend movements of the various series, during the eight overlapping decade periods, separated by a five-year span, since 1885. The table is restricted to basic series,[24] 57 in all, because the rates of increase of the other series fluctuate within a wider range over time and a common analysis of all series would therefore impart an artificial instability to the relative trend movements of the more important series. The first measure in the table states the average rank of each series: this measure is an arithmetic mean of the ranks of the eight decade rates of each series, the decade rates of the series having been ranked at each date on the principle of assigning a rank of 1 to the highest decade rate and a rank of 57 to the lowest decade rate. The second measure states the average deviation of the ranks of each series: this measure is an arithmetic mean of the deviations (signs ignored) of the eight ranks for each series, the deviations being measured from the arithmetic mean of the two middle-sized ranks. While the first measure states the average position of the trend advance of each industry in relation to the others, the second measure states the con-

[24] The composition of the group is that given in Appendix A, Table 46, column *f*, except for the two beverage series—fermented liquors and distilled spirits—which were dropped because they do not cover the full period through 1929. Comparisons of the relative position of trend movements are strictly valid for only the group of 57 series included. But in view of the substantial portion of the basic production area covered by these series, such a limited study should also throw considerable light on the stability in the relations of trend movements of basic industries in general.

sistency of the position of the trend advance of each industry in relation to the others.

These two measures impose a severe test on our data. The relative ranks of the trend movements of many industries have undergone a persistent change over the period since 1885: the trend advances of bituminous-coal, steel, coke, and cottonseed-oil production have declined relatively to the trend advances of other industries; the trend advances of petroleum production, silk imports, and tobacco consumption have increased relatively; and there have been other secular shifts in relative trend movements.[25] Secular shifts in the relative ranks of industries, no less than oscillatory shifts, make for increasing similarity in the average ranks of the various series and for increasing variability in the several ranks of each of the individual series. It is all the more remarkable, therefore, that the average ranks of the series show wide dissimilarity: the average deviation (measured from the median) of the average ranks of our series is 10.1, which compares with a maximum possible average deviation of average ranks of 14.2.[26] And it is further notable that the average deviations of the ranks of the individual series are, speaking generally, not very high: as many as 51 out of 57 series have average deviations below 14.2, which is the most probable average deviation under random conditions—that is, if each series had the same chance of having any one rank at each date as any other series. The statistical indications are, then, that there has been a fair degree of stability in the relative trend movements of industries even when we consider a period of a half-century during which many in-

[25] The ranks of relative trend advances of industries should not be confused with ranks in industrial importance—as measured by such yardsticks as value of product, number employed, etc.

[26] The clearest case of a maximum is when the ranks for each date constitute a perfect arithmetic progression, and when the average rank of each of the 57 series is identical with its rank at each date.

Table 14

MEASURES OF THE RELATIVE POSITION OF THE TREND MOVEMENTS OF BASIC SERIES, FOR 1885–1929

Series	Average rank	Average deviation of ranks
Cocoa imports	7.4	5.1
Petroleum	8.2	5.7
Steel	9.7	5.2
Cement, total	10.1	7.1
Silk imports, unmanufactured	10.8	6.8
Postage stamps	11.7	6.7
Copper consumption	13.3	6.3
Zinc consumption	13.6	5.6
Zinc	14.9	8.2
Rubber imports	15.8	14.2
Copper	17.4	9.5
Rolled iron and steel	18.9	7.3
Phosphate rock	19.0	11.4
Railway ton-miles	19.3	4.9
Salt	20.7	8.4
Deflated clearings	21.1	7.7
Silver consumption	21.8	9.6
Coke	22.2	9.6
Pig iron	22.6	5.6
Tin-plate consumption	23.0	9.7
Bituminous coal	23.4	9.3
Iron ore	24.1	9.9
Cottonseed oil	24.3	15.9
Tin imports	24.4	7.9
Tonnage entered and cleared	26.1	6.7
Railway freight	26.5	5.9
Lead, domestic	26.7	6.3
Lead consumption	27.0	6.2
Railway passenger-miles	29.3	12.7
Cotton consumption	31.0	4.7
Barley	31.2	12.5
Gold consumption	31.7	17.6
Raw sugar consumption	32.3	9.6
Flaxseed consumption	32.9	13.6
Coastal trade	33.9	10.9

Table 14 (cont.)

MEASURES OF THE RELATIVE POSITION OF THE TREND MOVEMENTS OF BASIC SERIES, FOR 1885–1929

Series	Average rank	Average deviation of ranks
Tobacco, raw	34.2	13.4
Sheep	34.9	12.7
Building permits	35.1	17.9
Coffee imports	35.2	11.9
Hogs	36.5	8.7
Cattle	36.5	9.2
Tobacco consumption	37.1	7.1
Rail consumption	37.9	17.6
Cotton	38.7	9.1
Gold	39.9	14.7
Potatoes	41.1	5.2
Oats	42.2	7.0
Minor fiber imports	43.9	6.2
Anthracite coal	44.2	5.7
Wheat	44.4	8.0
Wool consumption	45.1	6.9
Hay	45.4	3.6
Flour	45.6	4.1
Silver	46.4	7.9
Corn	46.6	5.3
Fish, total	47.2	4.6
Wool	48.4	6.1

dustries experienced persistent shifts in the relative ranks of their trend advances. Examining the measures of Table 14 in detail, we find that they correspond roughly to distinct industrial groups, and this is the best evidence that the stability indicated by the ensemble of measures cannot be a 'chance' result, that it reflects the influence of systematic economic forces. On the whole, series of industrial metals and their derivatives, and luxury goods have the lowest average ranks, indicating the primacy of their rates of ad-

vance; series of food and textile staples have the highest average ranks; and series indicative of construction, transportation, and trade have the medium ranks. On the whole again, series of foods, textiles, industrial metals and their derivatives, transportation, and trade have rather low average deviations of ranks, while series relating to construction and to the precious metals have rather high average deviations.

The statistical measures just considered run in terms of averages for a period of a half-century. If we are to learn more about stability in the relations of industrial trend advances, it is necessary to pass to the evidence of the decade-by-decade movements of industrial trends; this may be done by correlating the average rates of growth during one decade with the average rates of growth during other decades. If an interdecade correlation be positive, it will mean that the industries with relatively high rates of growth during one decade tended to have relatively high rates of growth during the other decade. If an interdecade correlation be negative, it will mean that the industries with relatively high rates of growth during one decade tended to have relatively low rates of growth during the other decade. A high coefficient of correlation will indicate considerable regularity in the changes in the pattern of production, while a low coefficient will indicate only mild regularity. Moreover, insofar as the coefficients of correlation are fairly high and positive, they will help to explain the relatively large variation in the average ranks of trend movements of the basic series group and the moderately low variation in the ranks of the decade rates of the individual basic series. It must be noted, however, that correlation technique can measure the degree of stability in the relative trend advances of only those industries which are common to the periods compared. In a rapidly moving economy, old commodities are constantly

falling into desuetude while new commodities are emerging. This portion of the production area is most unstable, and it completely eludes measurement in correlation analysis. Hence, even if the statistical materials encompassed fully that portion of the production area which is common to the periods compared, the coefficients of correlation would still understate the instability in the relative trend advances of the system of industries.

A record of the coefficients of correlation between average rates of growth of given decades and all other decades is presented in Tables 15–17, which relate respectively to 38

Table 15

COEFFICIENTS OF CORRELATION BETWEEN DECADE RATES OF 38 BASIC SERIES, FOR PAIRS OF DECADES INDICATED BY THEIR CENTRAL YEARS

Central decade year	1875	1880	1885	1890	1895	1900	1905	1910	1915	1920	1925
1875			.63		.58		.49		.20		.33
1880				.64		.60		.49		.18	
1885	.63				.59		.54		.36		.38
1890		.64				.52		.50		.09	
1895	.58		.59				.45		.08		.15
1900		.60		.52				.48		.29	
1905	.49		.54		.45				.52		.60
1910		.49		.50		.48				.54	
1915	.20		.36		.08		.52				.44
1920		.18		.09		.29		.54			
1925	.33		.38		.15		.60		.44		

Table 16

COEFFICIENTS OF CORRELATION BETWEEN DECADE RATES OF 57 BASIC SERIES, FOR PAIRS OF DECADES INDICATED BY THEIR CENTRAL YEARS

Central decade year	1890	1895	1900	1905	1910	1915	1920	1925
1890			.44		.46		.01	
1895				.44		.16		.22
1900	.44				.51		.23	
1905		.44				.39		.53
1910	.46		.51				.32	
1915		.16		.39				.29
1920	.01		.23		.32			
1925		.22		.53		.29		

basic production series covering the period since 1870, 57 basic series covering the period since 1885, and 44 basic non-agricultural series covering the same period.[27] A double entry is made in the tables for each of the decade combinations so as to facilitate reference. The outstanding feature of the record of correlations is that the coefficients are fairly high for contiguous decades, but become progressively lower as

[27] For purposes of simplicity, the correlations are confined to decades removed by ten-year steps or multiples thereof. The reasons for limiting the study to basic series are those set forth on p. 82. Except for the exclusion of fermented liquors and distilled spirits, the composition of the 38 basic series group, the 57 basic series group, and the 44 basic nonagricultural series group, is as listed in columns *b*, *f*, and *h*, respectively, of Table 46 in Appendix A. The group of 44 basic nonagricultural series differs from the group of 57 basic series in that it excludes the series of fish catch and the twelve agricultural series listed on p. 91, note 30.

Table 17

COEFFICIENTS OF CORRELATION BETWEEN DECADE RATES OF 44 BASIC NONAGRICULTURAL SERIES, FOR PAIRS OF DECADES INDICATED BY THEIR CENTRAL YEARS

Central decade year	1890	1895	1900	1905	1910	1915	1920	1925
1890			.36		.48		−.08	
1895				.37		.10		.17
1900	.36				.45		.13	
1905		.37				.36		.49
1910	.48		.45				.29	
1915		.10		.36				.31
1920	−.08		.13		.29			
1925		.17		.49		.31		

increasingly remote periods are correlated.[28] This is apparent from a careful reading of Tables 15–17, and it stands out conspicuously in Table 18 which presents arithmetic means of the coefficients for similarly spaced decades. The fact that the coefficients of correlation between the rates of growth of contiguous decades are fairly high indicates that there has been moderate regularity in the relations of the trend advances of industries during contiguous decades; this subject is investigated with more refined tools of analysis in Chapter V. The fact that the correlation tends to vanish as the periods compared become increasingly distant

[28] The coefficients of correlation were obtained by the Pearsonian method. They were checked by the method of rank correlation, which yielded about the same results. The term 'coefficient of correlation', as used throughout this work, refers to the Pearsonian coefficient.

Table 18

AVERAGES OF THE COEFFICIENTS OF CORRELATION BETWEEN DECADE RATES

Group	Number of cases	Average of coefficients
38 Basic series		
Contiguous decades	9	.53
Decades separated by ten years	7	.46
Decades separated by twenty years	5	.32
Decades separated by thirty years	3	.25
57 Basic series		
Contiguous decades	6	.40
Decades separated by ten years	4	.34
Decades separated by twenty years	2	.11
44 Basic nonagricultural series		
Contiguous decades	6	.36
Decades separated by ten years	4	.30
Decades separated by twenty years	2	.04

bears witness to the rapidity of change in the relations of industrial trend advances and, therefore, in the pattern of general industry.[29] These statistical results accord with a priori anticipations.

It will be noticed that the coefficients of correlation for basic nonagricultural series (Table 17) are lower than the

[29] If the degree of shift in the relative trend movements of industries followed any simple plan, that would be sharply reflected in the patterns formed by the coefficients of correlation in the several tables. If the degree of shift in the relative trend movements of industries were identical from decade to decade, the coefficients for contiguous decades would be constant; if, in addition, there were little tendency to revert to an earlier pattern of growth, the coefficients for separated decades would tend to decline as the intervening period increased, and the averages of the coefficients in successive columns (or rows) would therefore rise towards the center of the period and then decline. On the other hand, if the degree of shift increased rapidly, the coefficients for contiguous decades would have a sharp downward drift; if, in addition, there were little tendency to revert to an earlier pattern of growth, the averages of coefficients in successive columns (or rows) would tend to decline with time. Other patterns of coefficients may easily be imagined.

corresponding coefficients for basic series (Table 16) in ten of the twelve interdecade combinations. This systematic difference suggests that the coefficients for the basic series group may partly reflect a systematic differential between the average rates of growth of agricultural and nonagricultural industries; for, since agricultural industries have generally grown at lower rates than nonagricultural industries, a fair degree of correlation between interdecade rates might be evidenced by a composite of the two groups, even if there were little correlation in either group taken separately. While fairly high coefficients of correlation would not be without significance under such conditions, their meaning would be simply that the class of nonagricultural industries persistently grew more rapidly than the class of agricultural industries. The fact is that the 12 basic agricultural series,[30] taken by

There are two aspects of the patterns actually formed by the coefficients of correlation in Tables 15–17 which are worthy of notice. By far the more important is the decline in the coefficients as successively remote periods are correlated. This has been emphasized in the text, but it will bear additional statistical comment. Taking the coefficients in the three tables *en masse,* we find that coefficients for 'decades$_a$' with 'decades$_b$', where b is later than a but may or may not be contiguous to a, are higher than coefficients for 'decades$_a$' with 'decades$_{b+1}$' in most cases (18 out of 28); higher than coefficients for 'decades$_a$' with 'decades$_{b+2}$' in all cases (13 out of 13); and higher than coefficients for 'decades$_a$' with 'decades$_{b+3}$' or for 'decades$_a$' with 'decades$_{b+4}$' in all cases (5 out of 5).

Another aspect of the patterns actually formed by the coefficients of correlation in the several tables is something of a downward drift in the coefficients for contiguous decades. This suggests that the degree of stability in the relations of the trend advances of industries, and therefore in the changes in the pattern of production, has been declining. The indication of increasing instability is, however, of uncertain significance. Part of the drift in the coefficients reflects merely the drastic shift in the pattern of production during the decade including the War-period: the tables disclose the striking fact that the correlation between the rates of growth during 1910–20 and other decades is lower in every instance than the correlation between the rates of growth during 1920–29 (a remoter period) and corresponding decades. Moreover, the drift in the coefficients may arise from the decreasing statistical representation of the production area, which results unavoidably from the use of a fixed list of production series in the analysis of a progressive economy.

[30] The numbers of the series are: 1, 5–7, 9–10, 13–15, 18–20. (The most

themselves, show on the whole little correlation: the arithmetic mean of their coefficients for contiguous decades (6 cases) is .03, for decades separated by ten years (4 cases) .01, and decades separated by twenty years (2 cases) —.01. The paradoxical result of excluding the agricultural series (which themselves show little correlation) from the basic group is a reduction in the size of the coefficients for the remaining series, that is, the basic nonagricultural group; but this result confirms the hypothesis of heterogeneity in the behavior of industrial trends. While the coefficients for the basic nonagricultural series are somewhat lower than for the larger group including agriculture, they are still fairly high and statistically significant in the case of contiguous decades: they relate to a group which is roughly homogeneous from the standpoint of the average rates of growth in its major industrial divisions and which covers a very substantial portion of what may be considered as the area of basic nonagricultural industry.

The above observations indicate that agricultural and nonagricultural industries have differed considerably in the degree of stability of their respective relative trend movements. The same difference may be noted between agriculture and mining, an important subdivision of the nonagricultural group and the second great source of raw materials. While

convenient reference to the numbers of the series, quoted extensively in later footnotes, is provided in Table 1; though a key accompanies also Tables 44–47.) Even though these series cover a substantial portion of agricultural industry, coefficients of correlation for such a small number of items are of limited significance. But the 'errors' in the coefficients are likely to be compensatory in part, and averages of coefficients of the same time dimension are therefore of greater significance than individual coefficients. The coefficients between decades indicated by their central years are given in parentheses: 1890 and 1900 (.55), 1890 and 1910 (–.18), 1890 and 1920 (.01), 1895 and 1905 (.11), 1895 and 1915 (.09), 1895 and 1925 (–.03), 1900 and 1910 (–.01), 1900 and 1920 (–.30), 1905 and 1915 (–.05), 1905 and 1925 (.43), 1910 and 1920 (–.14), and 1915 and 1925 (–.27). It may be noted parenthetically that the 6 coefficients for contiguous decades show a marked and continuous decline over time. This may be merely a 'chance' result; see, however, the preceding note.

the agricultural series show practically no stability in their relative trend movements, mineral series show a fair degree of stability, as may be gathered from the coefficients for 12 basic mineral industries: [31] the arithmetic mean of their coefficients for contiguous decades (6 cases) is .49, for decades separated by ten years (4 cases) .39, and decades separated by twenty years (2 cases) .27.

The differences among major industrial divisions, in the relations of the advances of the secular trends of their individual industries, reflect differences in the underlying framework of their operation. The virtual absence of stability, speaking generally, in the relations of the trend movements of agricultural industries is due, in part, to the unspecialized character, and consequently, mobility, of a substantial portion of agricultural resources; in part, to the practice of substitution in the use of agricultural products; and finally, to the random impact of extrahuman factors which occasionally prove dominant, even though they are generally subsidiary to the factor of planning over intervals of some ten years or more. On the other hand, the relatively high stability in the relations of the trend advances of mineral industries is due, in part, to the specialized character, and consequently, immobility, of the factors of mineral production; [32] and in part, to the fair continuity in the relative trends of consumption of the industrial metals, fuels, and construction

[31] The numbers of these series are: 24–5, 27–9, 31–4, 36, 39, and 43. The coefficients between decades indicated by their central years are given in parentheses: 1890 and 1900 (.31), 1890 and 1910 (.42), 1890 and 1920 (.46), 1895 and 1905 (.29), 1895 and 1915 (−.25), 1895 and 1925 (.09), 1900 and 1910 (.67), 1900 and 1920 (.54), 1905 and 1915 (.38), 1905 and 1925 (.84), 1910 and 1920 (.79), 1915 and 1925 (.53). Concerning the interpretation of these individual coefficients, see the preceding note.

[32] Mineral resources admit of relatively unique uses only. To be sure, some discretion may be used in extracting ores which yield more of one metal than another, metallurgical treatment of ore admits of some variations in yield, more or less of natural gas may be recovered, and so on; but these are minor exceptions.

materials, which mines yield. Similar factors account for the moderate stability in the relative trend advances of other basic nonagricultural industries,[33] though the immobility of their resources is generally smaller than in mining.[34] Outside of the range of those nonagricultural industries which are basic, especially in the field of elaborative manufactures, the factor of substitution in consumptive use becomes of paramount importance: though the technical conditions of production conduce to stability in the relative trend advances of manufactures, their influence may be overriden easily by the volatile character of consumers' markets.

This analysis of the interdecade correlations of rates of industrial growth, the analysis of the relative positions of the trend movements of industries during 1885–1929, and the analysis of the differentials between the rates of industrial growth during 1885–1929 and such longer periods as the series cover, have yielded an inkling of the elements of order that have characterized the vast and rapid transformation in the industrial pattern of our national economy. What has been merely glimpsed in this chapter is illuminated in considerable detail in the two following chapters. Though accident has played no unimportant role in the changes in the

[33] Excluding the 12 mineral series from the basic nonagricultural group of 44 series (see p. 88, note 27, and p. 93, note 31) we have 32 series falling in the categories of manufacture, construction, transportation, and trade. The coefficients of correlation for this group for pairs of decades indicated by their central years are as follows: 1890 and 1900 (.38), 1890 and 1910 (.50), 1890 and 1920 (−.21), 1895 and 1905 (.36), 1895 and 1915 (.25), 1895 and 1925 (.25), 1900 and 1910 (.38), 1900 and 1920 (−.08), 1905 and 1915 (.48), 1905 and 1925 (.27), 1910 and 1920 (.14), 1915 and 1925 (.25). The arithmetic mean of these coefficients for contiguous decades (6 cases) is .33, for decades separated by ten years (4 cases) .23, and decades separated by twenty years (2 cases) .02.

[34] The forces which make for absence of stability in the relative advances of the secular trends of agricultural industries are, in large part, the same as those which make for only mild divergence in their primary trends; while the forces which make for moderate stability in the relative advances of the secular trends of nonagricultural industries are, in large part, the same as those which make for sharp divergence in their primary trends. See p. 67.

industrial composition of our rapidly developing economy, we shall find that there are clear and unmistakable threads of regularity in these changes, that the production trends of individual industries manifest remarkable behavior similarities.