CHAPTER 2

The General Secular Pattern

IN 1870, the initial year covered by this study, the regulated industries were the giants of the American economy. It was in these that the newly won technological wonders of the industrial revolution found—and for the next two decades continued to find—their most dramatic manifestations. To them, capital had been drawn from all sectors of the nation, and continued to flow in very large quantities. By 1870 the net value of the plant and equipment of the regulated industries had reached $8 billion, measured in terms of 1929 prices. This was somewhat more than the entire gross national product in that year. In the following decade, the average annual gross flow of capital to this segment of the economy, again figured at 1929 prices, exceeded $500 million. This was about 15 per cent of the entire nation's annual gross investment in this period—an aggregate which includes public as well as private construction, residential as well as industrial building, and producers' durables purchased by farms as well as by nonagricultural industries.

The principal components of the regulated group in 1870 were the steam railroads and privately owned water transportation and water supply. Of these, the railroads were the youngest and by far the most important. They accounted for 85 per cent of the total value of the plant and equipment of all regulated industries, and more than 80 per cent of their gross capital formation, net capital formation, and output.

Large as it was in 1870, the subsequent growth of the regulated group was very substantial. The size of the railroads, as measured by the constant dollar value of their road and equipment, increased more than threefold in the years subsequent to 1870. Street and electric railways by 1870 had made but a modest start with the horsecar toward the elaborate network which reached, with the application of electric power, almost every sector of the nation just forty years later. The commercial beginnings of telephones and electric light and power were not realized until the early 1880's. Local bus lines, and a number of the industries we embrace in the "all other" group, such as air transportation, motor trucking, radio communication, and pipe lines, were developed in the main in the period after World War I. This chapter focuses upon the growth of the group as a whole, mindful that its several parts bear common as well as many distinctive characteristics, as detailed in the following chapter.

An Over-All View, 1870–1950

Net capital formation, measured in constant dollars, represents net additions to the physical stock of capital—within the statistical limits described in the previous chapter. The uneven, gyrating pace of growth in the facilities of the regulated industries, so measured, is depicted by the broken line in the center panel of Chart 1. There is, of course, no purely straightforward way to pierce the swift procession of lofty peaks and cavernous troughs, so pronounced in this series, for a glimpse of the longer-term trend. Even the nine-year moving average, illustrated in the solid line of the center panel, leaves cycles of great magnitude and duration—the long cycles to be described in Chapter 7. Accordingly, several vantage points have been taken.

The first of these is the tabulation of the annual average net capital formation in regulated industries, for overlapping twenty-year periods, as given in Table 1. These figures suggest a gradual

TABLE 1

Annual Average Capital Formation of All Regulated Industries, by Twenty-Year Periods

(*millions of 1929 dollars*)

Period	*Net Capital Formation*	*Gross Capital Formation*
1870–1889	413	642
1880–1899	460	830
1890–1909	636	1,245
1900–1919	713	1,662
1910–1929	740	2,036
1920–1939	328	1,858
1930–1949	175	1,864

Source: Appendix Table B–1.

rise from an annual rate of somewhat more than 400 million 1929 dollars in the first twenty years to a peak of 740 million in the period 1910–29. Then there is a steady decline to a rate of less than 200 million in the final twenty years of the tabulation. The location of the peak before or after World War I, however, remains uncertain in this compilation. For net capital formation in the period 1900–19 is almost as great as in the period 1910–29. Furthermore, a comparison of the post World War II peak with those in previous periods is not possible within this framework.

Some further light is cast on these questions by the compilation of Table 2. This presents nine-year averages of net capital formation

TABLE 2

Annual Average Capital Formation of All Regulated Industries in Nine-Year Periods, Selected Dates

(*millions of 1929 dollars*)

Central Year of Nine-Year Average	*Net Capital Formation*	*Gross Capital Formation*
1876	273	464
1886	413	713
1896	452	949
1906	968	1,781
1916	368	1,566
1926	1,132	2,615
1936	−388	1,230
1946	717	2,542
1880	393	620
1890	562	925
1900	405	1,009
1910	1,137	2,113
1920	363	1,684
1930	433	2,003
1940	−73	1,573
1950	1,610	3,690

Source: Appendix Tables K–2 and K–4.

taken at selected dates at ten-year intervals. Here we discern a gradual rise in net capital formation from about 270 million 1929 dollars per annum in the 1870's to a peak in the neighborhood of the first fourteen years of the twentieth century, when investment proceeded at a rate of $1 billion a year or more. From this point onward the general drift of net capital formation was downward, at least until the years following World War II. To be sure, another peak is reached in the 1920's, about equal to that achieved around 1910, but it is apparent now that the high level of investment at the later date is not so sustained as at the earlier one. Thus, the peak nine-year average centered in 1926 of $1,130 million is preceded by figures of less than 400 million for the nine-year averages centered in 1920 and in 1916. It is followed, moreover, by an investment rate of little more than 400 million in the nine years centered in 1930. On the other hand, the 1910 peak of about 1,140 million 1929 dollars is preceded by a figure almost as large—nearly 1,000 million —for the nine years centered in 1906.

Similar consideration may be brought to bear upon the evaluation of the post-World War II peak, though here the picture—at least as it appears in Table 2—is not so clear. In order to provide full

consideration for the buoyant years following World War II, a special estimate was compiled for net capital formation of the regulated industries in the years 1951 through 1954, essentially beyond the time span established for this study. It will be observed that in the nine years centered in 1950 an additional investment peak was achieved, materially greater than those of 1926 and 1910. Here again, however, we may note that the peak is preceded by years of unusually low investment, as the tabulation shows. Indeed —to an even greater extent than in the 1920's—the huge post-World War II capital flow represented in important degree a process of recuperation from an extraordinarily severe and prolonged investment contraction. Nevertheless, it is apparent that proper perspective, from a secular standpoint, can be obtained only by taking explicit account of the long cycles which so clearly dominate this series. The computations of Table 3 were designed for this purpose.

TABLE 3

Annual Average Capital Formation of All Regulated Industries during Long Cycles, Dated from Nine-Year Moving Averages

(millions of 1929 dollars)

Long Cycle[a]	*Net Capital Formation*	*Gross Capital Formation*
1876–1898	432	765
1898–1918	722	1,620
1918–1935	483	1,961
1935–1946[b]	63	1,743

[a] Measured from trough to trough.

[b] Terminal date of series rather than cyclical trough.

Source: Appendix Tables K–2 and K–4. Terminal years of cycles are weighted one-half.

For this tabulation, cycles were marked off from the nine-year moving averages, which succeed in smoothing the shorter fluctuations. For the periods intervening successive troughs, the dates of which are given in the first column, annual averages of the nine-year moving averages of net capital formation were computed. Viewed in this framework, the general growth pattern is more distinctly outlined. The investment peak falls quite definitely in the earlier of the three doubtful periods—that is, in the dating of Table 3, somewhere in the span 1898–1918. This conclusion stands even when use is made of the special estimates for the years after 1950. The average annual net capital formation from the nine years centered in 1935 to the

nine years centered in 1950 was 367 million 1929 dollars, 25 per cent less than that of the 1918–35 period, and only half the rate prevailing in 1898–1918. Thus, this approach suggests that the secular peak in this series must be dated somewhere in the years preceding World War I.

Consideration of all three tables together, however, impels a more circumspect conclusion. It is true that placed against the broad historical background, the buoyancy of the years following World War II appears less dominating and impressive than it might otherwise seem. Nevertheless capital formation reached heights in these years well in excess of all previous levels. It is reasonably clear, at least, that the secular trend since 1910 has not headed *sharply downward.* On the other side, our analysis precludes the judgment that the long-term movement was still heading *sharply upward.* Beyond this it is difficult to go. Three possibilities must be admitted: (1) that the long-term trend since 1910 was horizontal; (2) that it was rising slightly; (3) that it was falling slightly. For brevity we shall speak of the secular trend in net capital formation of the regulated industries as being "virtually horizontal" since about 1910.

A somewhat different impression of the development of the regulated industries is obtained from examination of the bottom panel of Chart 1. Gross capital formation embraces the *entire* flow of machines, buildings, and other capital equipment to the regulated industries, including that required both for the maintenance of their stock of plant and equipment as well as for expansion. It is thus the total demand made upon the economy by the regulated industries for capital goods, and is equal to net capital formation plus capital consumption.

The gross flow of investment evidences no downward tendency after World War I, or even a suggestion of a horizontal movement, as was the case for net capital formation. The general drift of the charted data appears distinctly upward. The figures of both Tables 1 and 3 show that the gross investment peak of the 1920's was substantially larger than that of the immediate pre-World War I period. And the data of Table 2, including the preliminary estimate for the relevant years of the 1950's, show that the post-World War II peak was, by a substantial margin, the greatest of all. In the nine years centered in 1950, gross capital formation proceeded at the annual rate of 3,690 million 1929 dollars, fully eight times the rate which had prevailed in the 1870's.

Of course the difference between gross and net capital formation is capital consumption. And the divergent behavior of the first two implies the general trend of the last. Capital consumption rose from

about 180 million 1929 dollars per annum in the 1870's to a rate of nearly 1,800 million a year in the 1940's as shown in Table 4. In the 1870's capital consumption was about half the size of net capital formation. By the 1940's capital consumption had reached a rate about three times as great as net capital formation.

This phenomenal increase is, of course, inevitable in a growing industry. As long as net capital formation remains positive on balance—that is, as long as the total stock of capital continues to grow—capital consumption must increase. A logical exception—though hardly of practical import—would occur if the economic life

TABLE 4

Annual Average Capital Consumption of All Regulated Industries, by Decades

(*millions of 1929 dollars*)

Decade	*Capital Consumption*
1870–1879	178
1880–1889	279
1890–1899	461
1900–1909	757
1910–1919	1,141
1920–1929	1,449
1930–1939	1,612
1940–1949	1,766

Source: Appendix Table B–1.

of new capital used for replacement and expansion were materially expanded. And even this would arrest the advance of capital consumption only for a limited time, unless the economic life of plant and equipment was subject to *indefinite* and *continuous* extension.

Furthermore, barring the improbable exception noted above, the expansion of capital consumption to a size greatly exceeding net capital formation is also inevitable. For net capital formation is bound—ultimately—to decline relative to the total stock of capital; to maintain even a constant ratio it would have to increase (absolutely) to infinitely high amounts. If the ratio of capital consumption to the total stock of capital remains constant, increases, or declines only modestly, capital consumption must sooner or later equal and then exceed net capital formation. In the regulated industries as a group, the period of equality was reached—roughly—in the 1890's. And we have seen how rapidly after this date capital consumption outstripped net capital formation. A special circumstance, however,

accelerated this movement. This was the growth of new industries such as telephones, electric light and power, trucking, local bus lines, and air transportation, virtually all of which had higher rates of capital consumption than the older giant of utilities, the railroads. Thus, in the regulated industries as a group, the ratio of capital consumption to the stock of capital increased rapidly. And in absolute magnitude, capital consumption swiftly dwarfed net capital formation.

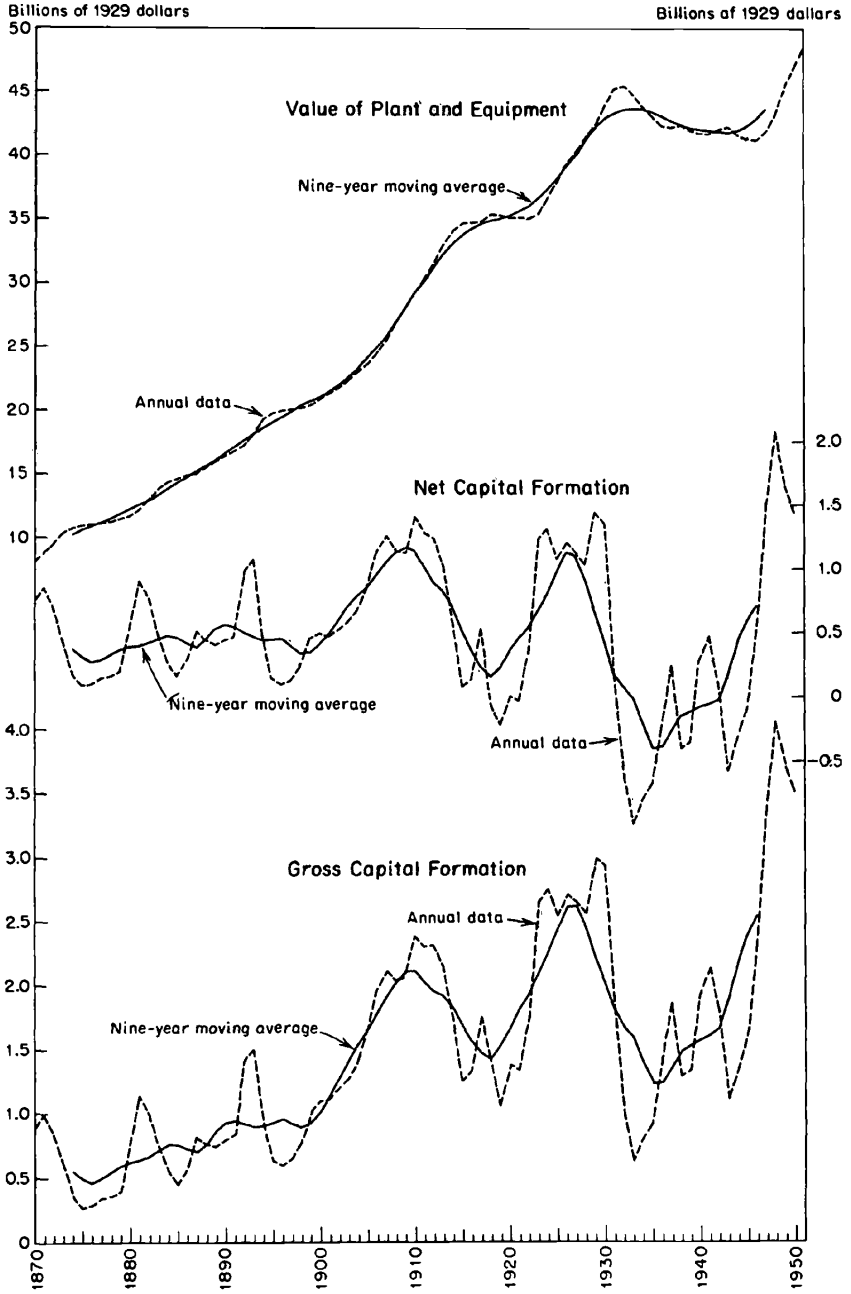
The net result of the growth of the regulated industries is reflected in the expanding volume of their total stock of plant and equipment, depicted in the top panel of Chart 1. Physical capital exclusive of land, and measured in 1929 dollars, aggregated about $8 billion in 1870; by 1889 it amounted to $16 billion, and by 1912—at $32 billion—it had doubled again. By the end of 1950 it was at a new peak of 48 billion 1929 dollars. Net capital formation, discussed above, is of course identical with *changes* in the volume of plant and equipment; it measures, strictly speaking, the absolute rate of growth. And it will be recalled that the trend of net capital formation was approximately horizontal after 1910; when expressed as a ratio to the stock of capital, therefore, it would be expected to decline. In other words, the trend of net capital formation as described above indicates that the *relative* rate of growth in the stock of capital must have been retarded, at least after World War I. That indeed it was, is shown directly by the data of Table 5.

Percentage changes in the stock of capital appear to reach a peak in the ten or fifteen years prior to World War I. After this date they decline swiftly. Even the post-World War II flurry of investment fails to approach, on a relative scale, the previous peak. Furthermore, prior to the pre-World War I high the rise is not nearly so steep, when measured relatively, as it was in the absolute terms of net capital formation. Indeed the percentage increases in the 1870's and 1880's were but little below the peak rate reached in the decade or so before World War I. Relatively, the growth of the entire stock of plant and equipment of the regulated industries sloped slightly upward from 1870 to about 1910, and declined sharply thereafter. In contrast, the *absolute* rate of growth (net capital formation) had advanced vigorously up to 1910, and leveled off in the neighborhood of the peak in subsequent years.

In Table 6 the trend in the relative growth of the value of plant and equipment, measured in constant dollars, is shown in a different framework. Long cycle peaks were marked off in the nine-year moving averages of the series, and average annual percentage changes were computed for the intervening periods. Because of the great

CHART 1

Value of Plant and Equipment and Capital Formation, All Regulated Industries, 1929 Dollars, 1870–1951



Source: Appendix Tables B-1; K-1, 2, 4.

TABLE 5

Percentage Changes in Constant Dollar Value of Plant and Equipment and of Output, All Regulated Industries

Years	*Per Cent*	*Years*	*Per Cent*
	PLANT AND EQUIPMENT[a]		
1870–1880	38	1876–1886	34
1880–1890	38	1886–1896	35
1890–1900	27	1896–1906	23
1900–1910	43	1906–1916	42
1910–1920	15	1916–1926	13
1920–1930	29	1926–1936	8
1930–1940	−8	1936–1946	−3
1940–1950	16		
	OUTPUT[b]		
		1886–1896	84
1890–1900	91	1896–1906	120
1900–1910	100	1906–1916	72
1910–1920	57	1916–1926	36
1920–1930	16	1926–1936	0
1930–1940	51	1936–1946	119
1940–1950	65		

[a] Values as of the beginning of the year.

[b] Percentage changes were computed from the nine-year moving averages, except that for 1950 the annual figure was used.

Source: Appendix Tables B–1 and K–9.

TABLE 6

Annual Average Percentage Increases in Constant Dollar Value of Plant and Equipment, All Regulated Industries, during Long Cycles

(*based on nine-year moving averages*)

Peak Dates of Long Cycle	*Percentage Increase*
1875–1914	3.0
1914–1931	1.6
1931–1947[a]	0.03

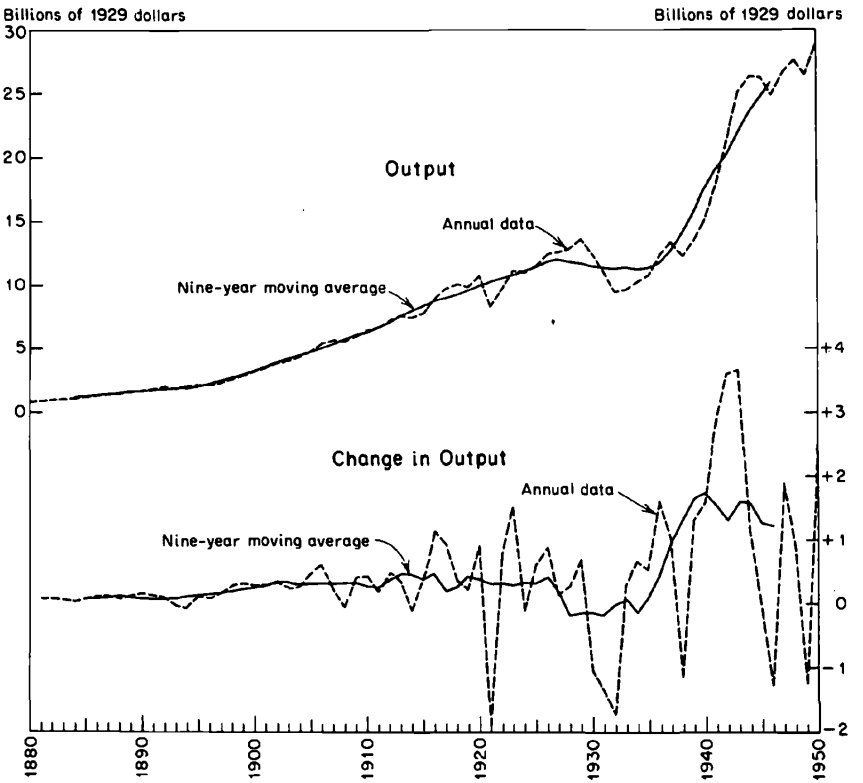
[a] Terminal date in nine-year moving average series.

Source: Appendix Table K–1.

length of the period between the first two peaks, the stage of slightly rising percentage increases prior to 1910 is obscured in this table. On the other hand, this framework presents a more concise summary of the magnitude of the over-all decline in percentage increases. For it is more clearly evident here that the trend is sharply downward, from 3 per cent per annum between 1875 and 1914, to less than 2

CHART 2

Output and Changes in Output, All Regulated Industries, 1929 Dollars, 1880–1950



Source: Appendix Tables I-1, 30; K-9, 11.

per cent per annum between 1914 and 1931, and finally to a fraction of one-tenth of 1 per cent between 1931 and 1947.

The striking thing about the production of the regulated industries from 1870 to 1950 is the vigor of its rise. This is illustrated in the upper panel of Chart 2. Measured in terms of 1929 dollars, it rose from less than 1 billion in 1880 to more than 2 billion in 1897, to more than 4 billion in 1905, to more than 8 billion in 1918, and to nearly 17 billion in 1948. Nor did the absolute rate of increase tend to level off. This is illustrated indirectly by the general curvature of the series depicted in the upper panel of the chart, for it rather obviously heads upward at an ever-increasing pace. It is shown directly in the lower panel in which year-to-year changes in output

are plotted. Despite the highly erratic behavior of this series it is apparent that the general trend is upward.

Moreover, though the general trend of relative increases in output is downward, the decline is fairly modest, especially when compared with the corresponding drop—at least after 1910—in relative increases in the stock of plant and equipment previously discussed. This is shown in Table 5. It should be noted that it was possible to compile the series on output only back to 1880, in contrast with the investment series which begin in 1870. Because of the relatively volatile nature of output behavior, percentage changes were computed from nine-year moving averages. Thus, the 1890–1900 output figure in Table 5 shows that from the average of the nine years centered in 1890 to the average of the nine years centered in 1900, output rose by 91 per cent. It may be observed that the percentage increase from 1936–46 was very nearly as great as the all-time high reached from 1896–1906. Nevertheless, considering both columns of relative changes, and bearing in mind also the cyclical nature of this series, it is apparent that the relative rate of growth in output from 1880–1950 was moderately downward.

A Model Pattern

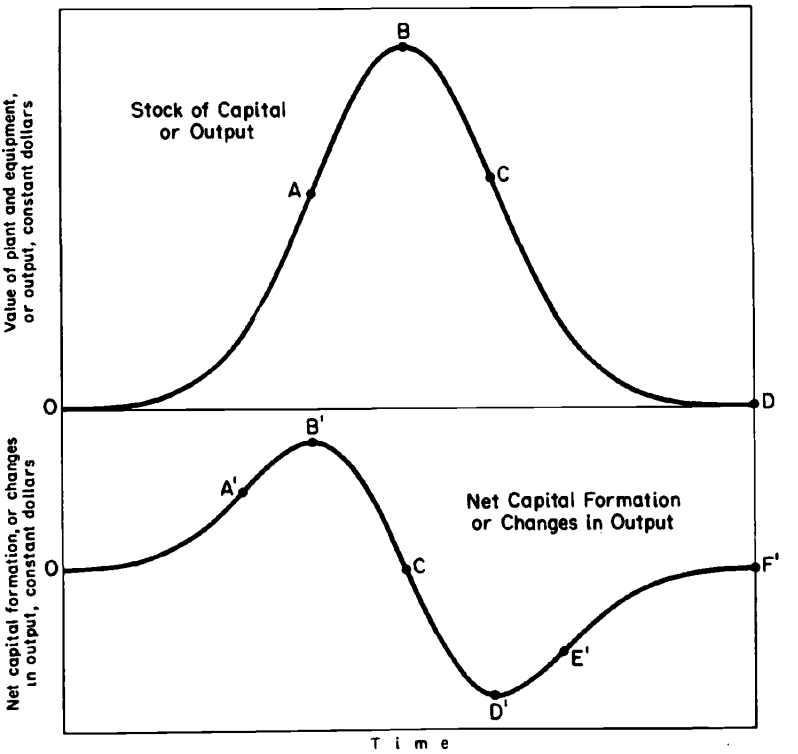
The considerations above suggest a familiar pattern of growth, to which attention may be called at this point. Not only the totality of all regulated industries, but also each of the selected individual components, discussed in the next chapter, appear to conform—at least roughly—to this pattern. For this reason it will be described more fully than would otherwise have been necessary. For it must be borne in mind that the regulated industries in the aggregate are far from a homogeneous group, embracing as they do a wide variety of functions. The application of a model to the behavior of the totality, therefore, can at best be of descriptive utility only.

An ideal model of the pattern is illustrated in the solid lines of Chart 3. The form of the curve in the upper panel of the chart is of course similar to that employed frequently in the past to describe the time path in the output of many mining and manufacturing industries.[1] It is used here to depict the secular behavior of the physical stock of reproducible capital as well as of output. It is composed of the following "stages," of importance to our analysis: (1) it initially rises by increasing amounts per unit of time until it reaches an inflexion point at A; (2) it continues to rise, but by diminishing amounts, up to the peak at B; (3) it declines by increasing amounts

[1] Cf. Arthur F. Burns, *Production Trends in the United States since 1870* (National Bureau of Economic Research, 1934).

CHART 3

Model Pattern of Secular Growth in Industry



up to the inflexion point at C; (4) it continues to decline, but by diminishing amounts, until it reaches zero at D.

The curve in the lower panel of the chart is designed to depict the secular pattern of net capital formation or of *changes* in output, and is therefore the derivative of the one above. It, too, contains component stages of interest here. It rises at an increasing rate until A′, continues upward, but at a diminishing rate, until B′ (corresponding to point A in the upper curve); declines at an increasing rate until zero is reached at C′ (corresponding to B above), declines at a diminishing rate until D′ (corresponding to C above), rises at an increasing rate to E′ and at a diminishing rate until zero is reached again at F′ (corresponding to D above).

With this model as background, we may compare the behavior of capital formation and of output in the aggregate of the regulated industries. Throughout almost the entirety of the span of study the

constant dollar value of plant and equipment rose at an increasing rate. In terms of Chart 3, this means that the stock of capital had not yet passed point A in the upper panel. Net capital formation, on the other hand, had shown fairly clear signs of leveling off. Perhaps even before 1870, and certainly by not much later, net capital formation had ceased to rise by increasing amounts over time.[2] The pace of its advance was distinctly retarded. In terms of Chart 3, net capital formation had passed point A′. In the sense that a *rising* tendency in investment has ceased to be pronounced, secularly, we may say that the stock of capital of the regulated industries was approaching point A, and that net capital formation was drawing close to point B′ in the model pattern. This implies, too, that the secular trend in investment was at its highest point in history at the close of our period of study, and may have still been moving upward, though slowly.

The regulated industries as a group appear even more youthful when viewed from the standpoint of their production. In terms of the model diagram, the secular trend of output in 1950 had not yet reached point A; but even more than this, the secular trend of changes in output had yet to reach point A′. This means that the long-term trend of output of the regulated industries moved upward throughout the 1870–1950 span at an ever-expanding rate; and that the *changes* in output also advanced at an increasing rate over this period. Previously, we have shown that year-to-year *percentage* changes in output have tended to decline moderately. We emphasize here, however, that the absolute increments have continued to tend upward—a fact which for some purposes is perhaps of more significance. A more vigorous pattern of growth is barely possible in an industry group which is among the oldest in the American economy.

Significance of the Model

Observations made in the section on the model pattern are of course consistent with the conclusions drawn in earlier pages from an analysis of tabular materials. The pattern served only as a descriptive device. In the following chapter it shall serve also as a framework for ready appraisal and comparison of the several individual regulated industries selected for separate study.

It may also be suggested, perhaps, that the growth model adds an entirely new dimension to the analysis thus far undertaken. For does it not imply something about both past and future? Should

[2] A mathematical curve approximating our model was fitted to the data, and suggested a date for inflexion point A′ at about 1875.

not mathematical curves—empirical approximations of our model —be fitted to the data and employed for predictive purposes of interest? With reference to the period *prior* to 1870, fragmentary evidence permits us to say that what such curves would imply, broadly, is very likely true. Extrapolating them over future years presents other problems. Past experience provides sufficient caution against mechanical projections of this order. For economic history is larded with mathematical patterns adhered to for a time and then abruptly broken.[3] The very nature of economic activity warns against excessive confidence in a mere mathematical model. The power of these warnings is increased manifold when, as in the present case, the model applies to an aggregate of many industries with a wide variety of heterogeneous characteristics. Until, or unless, a model of this type can be supplemented with considerations of another order—those referring to *causal* relationships and the reasons for the behavior summarized—it must remain of descriptive utility only. We should caution, in particular, that no assumption can be made about the chronological *duration* of the various stages of the model. Indeed, as the next chapter shows, these may vary almost without limit. Hence their value for some *mechanical* scheme for prediction is next to nothing.

In the broadest terms, however, some analytical justification may be suggested now for the use of a model of this general type when applied to more homogeneous groupings, as it is in the following chapter. This stems from the expectation, on theoretical grounds as well as on the basis of previous studies,[4] that the rate of growth of an industry is *ultimately* retarded. This idea—which is expanded in Chapter 5—suggests a tendency for each of the regulated industries to follow our model pattern of growth (or some similar version of it) at least part way. The model is therefore illustrative of certain observable uniformities of behavior. As such, it provides a useful framework for the broader analysis of trends which is undertaken later.

[3] Cf. Harold T. Davis, *The Theory of Econometrics* (Principia, 1941), Chapter 11. Numerous mathematical "laws" are defined for industrial growth; virtually all have since been flagrantly violated.

[4] Burns, *op. cit.*, and Simon Kuznets, *Secular Trends in Production and Prices* (Houghton Mifflin, 1930).