Volume Title: Capital in Transportation, Communications, and Public Utilities: Its Formation and Financing

Volume Author/Editor: Melville J. Ulmer

Volume Publisher: Princeton University Press

Volume ISBN: 0-870-14102-3

Volume URL: http://www.nber.org/books/ulme60-1

Publication Date: 1960

Chapter Title: Front matter to "Capital in Transportation, Communications, and Public Utilities: Its Formation and Financing"

Chapter Author: Melville J. Ulmer

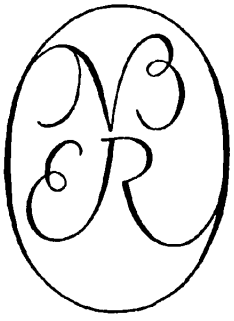
Chapter URL: http://www.nber.org/chapters/c1486

Chapter pages in book: (p. -43 - 32)

Capital in Transportation, Communications, and Public Utilities:

Its Formation and Financing

BY MELVILLE J. ULMER
THE AMERICAN UNIVERSITY



A STUDY BY THE
NATIONAL BUREAU OF ECONOMIC RESEARCH

PUBLISHED BY
PRINCETON UNIVERSITY PRESS, PRINCETON
1960

L.C. Card No. 59-11082

Printed in the United States of America

SYSTEMS & FORMS CO., P.O. BOX 311, ANN ARBOR, MICHIGAN

INTERNAL WORK ORDER

DATE 10/30/72 BOOK ☒ FILM ☐ OP BOOK NO. 2,001,203 ~~2,001,192~~

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National Bureau of Economic Research

SUB. BY PUB.

Capital in transportation, communications, and public utilities: its formation and financing by Melville J. Ulmer.

X-ref: Ulmer, Melville J.
Series: National Bureau of Economic Research

Princeton University Press

1960

(Studies in capital formation and financing, no. 4)

MIC. ONLY ☐ 59-11082

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Ulmer, Melville Jack, 1911–

Capital in transportation, communications, and public utilities: its formation and financing. Princeton, Princeton University Press, 1960.

xxxviii, 548 p. diagrs., tables. 24 cm. (National Bureau of Economic Research. Studies in capital formation and financing, 4)

Bibliographical footnotes.

1. Public utilities—U. S.—Finance. 2. Saving and investment—U. S. I. Title. (Series)

HD2766.U4 380 59-13871

CAPITAL IN TRANSPORTATION, COMMUNICATIONS, AND PUBLIC UTILITIES: ITS FORMATION AND FINANCING

NATIONAL BUREAU OF ECONOMIC RESEARCH

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1. Capital Formation in Residential Real Estate: Trends and Prospects
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   Raymond W. Goldsmith
4. Capital in Transportation, Communications, and Public Utilities: Its Formation and Financing
   Melville J. Ulmer

This monograph is part of a larger investigation of trends and prospects in capital formation and financing made possible by a grant from the Life Insurance Association of America

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FOREWORD

by Simon Kuznets

I

THIS is the fourth in a series of monographs resulting from an inquiry initiated by the National Bureau of Economic Research in 1950, with the financial assistance of the Life Insurance Association of America.[1] The inquiry examines long-term trends in capital formation and financing in the United States, and is organized primarily about the principal capital-using sectors of the economy—agriculture, mining, manufacturing, the public utilities, residential real estate, and governments. The analysis for each sector summarizes the major trends in real capital formation from 1870 (or the earliest year for which data are available), and in financing from 1900, or somewhat earlier. In each, an effort is also made to discover the factors determining these trends, and, so far as possible, to suggest the significance of these factors for the future. In addition to the sector studies, the inquiry comprises two others. One deals with trends in external financing channeled through intermediate financial institutions and attempts to link the major types of institutions with the various groups of capital users. The second integrates the results of all the other studies, within a framework provided by country-wide estimates of national product and relevant components, and of country-wide estimates of assets and debts.

Some of the findings have been presented in part or in preliminary form in a series of Occasional and Technical Papers.[2] This monograph, like those to follow, presents the full results of a specific study together with supporting data. The three others, near completion, deal with trends in capital formation and financing in mining and manufacturing, and in governments, respectively; and

[1] The first three monographs are: *Capital Formation in Residential Real Estate: Trends and Prospects*, by Leo Grebler, David M. Blank, and Louis Winnick (1956); *Capital in Agriculture: Its Formation and Financing since 1870*, by Alvin S. Tostlebe (1957), and *Financial Intermediaries in the American Economy since 1900*, by Raymond W. Goldsmith (1958), all published for the National Bureau of Economic Research by Princeton University Press.

[2] Leo Grebler, *The Role of Federal Credit Aids in Residential Construction*, Occasional Paper 39 (1953); Daniel Creamer, *Capital and Output Trends in Manufacturing Industries, 1880–1948*, Occasional Paper 41 (1954); Raymond W. Goldsmith, *The Share of Financial Intermediaries in National Wealth and National Assets, 1900–1949*, Occasional Paper 42 (1954); Melville J. Ulmer, *Trends and Cycles in Capital Formation by United States Railroads, 1870–1950*, Occasional Paper 43 (1954); Alvin S. Tostlebe, *The Growth of Physical Capital in Agriculture, 1870–1950*, Occasional Paper 44 (1954); Israel Borenstein, *Capital and Output Trends in Mining Industries, 1870–1948*, Occasional Paper 45 (1954); David M. Blank, *The Volume of Residential Construction, 1889–1950*, Technical Paper 9 (1954); all published by the National Bureau of Economic Research.

with a summary presentation and analysis of trends in capital formation and financing for the country as a whole.

II

The regulated industries, whose long-term record is analyzed in Dr. Ulmer's monograph, have a number of distinctive characteristics. At the risk of repeating the obvious, it may be useful to list them briefly.

First, most regulated industries are products of modern technology —of new ways of providing energy for industrial and household uses, of harnessing energy to the transportation of goods and persons and to the communication of messages, written and oral. Many of these industries could not have existed a hundred or a hundred and fifty years ago because neither the practical inventions, nor even the theoretical discoveries underlying their operation, were known.

Second, because of the large volume of concentrated power involved in the modern technology of regulated industries, they require—for *minimal* operation—huge investments of durable capital: in roadbeds or roadways, terminal stations and airfields, power equipment, transmission lines, control stations, etc. For optimum *economical* operation such durable capital investment must be even larger relative to current rates of output—to exploit the internal economies of large-scale production and to provide for the secular rise in demand.

Third, since so many of the regulated industries are concerned with transportation and communication, the efficiency of their output depends upon a rapid integration of local and regional units into a country-wide—and sometimes international—network. A single railroad is far less effective economically than one which is part of a country-wide system; and the same can be said of a single truck company, air transport company, or telephone firm, unless, of course, each is already so large as to be able to provide effective integrated service throughout the country. Hence, once such a transportation or communication industry emerges, it is under great pressure to extend its network—and thus its capital investment—to cover the country; and perhaps link up with similar industries in other countries.

Fourth, the large size of durable capital investment relative to current output makes for a high ratio of fixed to variable costs—and leads to the classical case where, in the long run, competition within the industry ends in monopoly by killing off all competitors but one. By their very structure as producers, many regulated industries are naturally monopolistic.

Fifth, since the industries in the group are in the business of supplying power and other necessities (like water), or of providing transportation and communication services, the products constitute a basic framework for much of economic and social life. All of us need the products; and their availability, once established, permits changes in the pattern of life designed to take advantage of them (e.g. of new transportation facilities). The consequence is that the withdrawal of the products of regulated industries, an interruption in their supply, would create severe and widely ramifying difficulties throughout the country's economy. In other words, regulated industries are suppliers of goods that can be viewed practically as basic necessities.

Sixth, it is, of course, this combination of monopolistic position and provision of necessities that results in the industries[1] being regulated—treated as public utilities[3]—in countries where nationalization can be avoided. Were the industries concerned with minor luxuries, such as artificial hair buns or fancy cigarette holders, few would care about the monopolistic power of the producers—where the latter happened to possess them. If the goods were necessities, but the industry naturally competitive (as with many agricultural and industrial products), reliance could be placed on the free competitive market and little special regulation would be required. A public utility must be regulated for the joint reason that, as the term implies, it is of wide and basic use, and yet its technology and economics bar the possibility of effective intra-industry competition.

Finally, even though the degree of monopoly is high *within* each regulated industry, in the long-term perspective one can observe a great deal of *inter-industry* competition. Surely the railroads have been affected in recent decades by the competition of motor trucks and of airplanes; electric power competes for certain types of household use with gas; there is even competition, limited though it may be, between the telephone and telegraph. Indeed, it may be suggested that the very origin of regulated industries in recent technical progress and the wide field which they cover raise the probability that, as time passes, competitive pressure on some already existing industries will be exercised by newly emerging methods of providing power, transportation, or communication services—methods so new as to provide a base for new industries. And one may add that as such new industries are born, and exercise

[3] Dr. Ulmer's definition of regulated industries embraces a group somewhat wider than public utilities, but sufficiently close to it to say that by far the predominant part of the group are privately owned public utilities. (Government-owned units are excluded by Dr. Ulmer from the analysis; but in many of the subsectors, government ownership in this country is insignificant.)

competitive pressure on those already existing, the new sectors—even though still undergoing internal competition—may promptly be subjected to special controls and thus be added to the regulated group.

III

The characteristics just listed go far to explain the long-term movements of output, capital formation, capital-output ratios, and sources of financing, which are so clearly portrayed and cogently analyzed in Dr. Ulmer's monograph. His main conclusions can be briefly stated.

(1) As each of the major industries with which Dr. Ulmer deals separately (steam railroads, electric light and power, telephones, street and electric railways, local bus lines) emerges, its output grows at high rates—far higher than those in country-wide output. As a result, its share in total national output also rises rapidly. The steam railroads, much of whose early growth preceded the period covered here, accounted for about 5 per cent of gross national product in 1886 (their share in the 1830's must have been nearly zero), and rose to almost 9 per cent by the early 1920's. Electric light and power, whose share was close to zero in the early 1890's, rose to over 4 per cent of gross national product in the 1950's; the share of telephones, from close to zero in the early 1890's to over 1.5 per cent in the 1950's; and that of street and electric railways, which emerged in the 1890's, to a peak of about 1.4 per cent in 1916.[4] But such rapid growth—greatly in excess even of the vigorous growth of national output—ceases, after some decades. The timing differs from one industry to another, depending upon its scope and its susceptibility to competitive pressure from new industries. From a peak level in the early 1920's of 9 per cent of gross national product, the share of steam railroads drops to 5 per cent by 1950; that of street and electric railways declines from 1.4 per cent in 1916 to 0.2 in 1950; and even for those industries that are still growing relatively vigorously, such as electric light and power and telephones, the rise in share of total output, rapid at first, slows down materially.

This pattern of a life cycle of growth of output in the regulated industries is clearly associated with their origin: their emergence as a product of a major technological change which, as Dr. Ulmer points out, fills the vacuum of a felt need, of a wide potential market. The improvements that follow soon upon the introduction of the new technology, and the pressure on transportation and communication to build quickly toward an integrated country-wide

[4] All of these figures are from Tables 22 and 23 in the monograph.

framework, provide the continuous stimulus to a high rate of growth in the early phases of the industry's history. Then, as the national network is completed, as the original need is gradually satisfied, and as competitive pressures arise because of new technological changes, the rate of growth diminishes; and in some cases absolute and relative declines may set in.

(2) The long-term trends in capital formation are similar to the trends in output in that high rates of growth prevail in the early phases and then retardation begins. Plant and equipment grew in the regulated industries at rates averaging over 30 per cent per decade for the period from 1870 to 1910; but at a rate averaging only about 10 per cent per decade for the period from 1910 to 1950 (see Table 5). Net additions to durable capital of public utilities accounted for well over a fifth of all additions to durable capital in 1880–90; probably appreciably less than that in the earlier decades; about a fifth for the period 1880–1912; but less than a tenth for the period 1912–48. In other words, capital formation in the regulated industries, like output, first grew more rapidly than that for the nation and then declined materially as a share of the national total. This finding—that the trend pattern of capital formation reproduces that of output but in a magnified fashion and within a shorter time span—was to be expected. For the capital plant had to be built in advance of prospective demand and output, and as the technology became stabilized and the turbulent growth of output itself slowed down, higher rates of utilization and capital-saving economies made it possible to reduce the rate of growth of capital investment even more than the rate of growth of output was reduced.

(3) This relation between growth of output and of capital formation is reflected most clearly in the trends of the capital-output ratios. Among regulated industries the ratios of capital to output, which in most cases were much higher than for the country as a whole, have declined precipitously—if not from the very beginning, then from not long after the industry's birth. In steam railroads the ratio declined from about 16 in 1880 to less than 3 in the 1950's; in electric light and power, from 16 and more in the early 1890's to less than 2 in the 1950's; in telephones, from 4 or 5 in the 1890's to less than 2 in the 1950's; and in street and electric railways, from about 7 at the end of the 1890's to less than 3 in the 1950's (all of these figures from Charts 17 through 20 in the monograph). It is clear that the very large volume of durable capital investment, relative to current output, which was required in the regulated industries—particularly during the early phases of extensive growth and construction of the networks—provided the opportunity and

the incentive for reducing the capital-output ratio, so that the resulting reductions were greater, both absolutely and relatively, than in most other industries in the country.

(4) The rate of growth of gross capital formation fell markedly from the high levels of the early decades—partly because of the slowing down in the rate of growth of output, and even more because of rising rates of utilization of capacity and of capital-saving innovations. But this meant that the ratio of capital depreciation to current capital formation would, all other conditions being equal, grow; and as Dr. Ulmer demonstrates, growth in the ratio of depreciation to gross investment was a major factor contributing to striking long-term changes in the sources of financing. Whereas in the early decades financing was almost wholly from external sources and came largely from new issues of stocks and bonds, in the later decades internal financing—retained profits and especially depreciation charges—loomed much larger; in some industries, such as steam railroads, dominating the picture completely. True, other factors were involved; and we must always consider the effect of price changes, in scanning movements of capital formation in constant dollars to infer trends in sources of financing. But even some of these other factors—for example, changes in the future prospects of the industry which clearly affect its chances of securing external funds in long-term capital markets—are, like the growing ratio of capital depreciation to gross capital investment, aspects of the life cycle pattern of growth traceable to the distinctive characteristics of the regulated industries.

(5) Finally, attention must be called to the long swings that so clearly characterized capital formation in the regulated industries—particularly in steam railroads, whose record is the longest. The association between them and long swings in other important aspects of the economy is discussed in detail in Chapter 7 of the monograph. In the present context, it is important to stress that many of the regulated industries provide consumer goods and should, in general, be quite sensitive to population movements; and additions to the durable capital in them, like additions to residential housing, should be responsive to additions to population and to internal migration. Given the long swings in additions to population and in internal migration, it is this association that may be at the root of long swings in capital formation in the regulated industries.

Two comments should be added to this too-brief summary of Dr. Ulmer's findings. First, the trend patterns in output, capital formation, capital-output ratios, and sources of financing—as well

as the susceptibility to long swings—that are so clearly apparent in the regulated industries can be found also in many other sectors. New industries, emerging as a result of new technological changes, are likely to go through similar life cycles of output, capital formation, capital-output ratios, and sources of financing; and if they happen to be responsive to population changes, may also show long swings. But because of the distinctive characteristics of regulated industries, these trends and long-term movements stand out with special prominence, and possibly provide a clearer insight into the causal mechanisms that bring them about.

Second, regulated industries are a category that includes subsectors at different stages of growth, and hence at different phases of their life cycle pattern. Any attempt at projection of the future from the past must, as Dr. Ulmer clearly shows, take account of this diversity of behavior within the group; and particularly of the possibility that the scope of the group will be expanded in the future by the addition of new industries, now in their very early stages or still to be born. It is the difficulty of appraising the potentials of the future with respect not only to the industry already existing and with clearly observable trends, but as well to new industries in the making, that renders projection so hazardous. And the rapidity of change, the short period of two to three decades in which an industry could grow, in the past, to unprecedented importance, is a warning that should be given due weight in avoiding oversimplified projection from the record.

IV

The comments above can hardly do justice to the analytical framework and to the empirical foundation of Dr. Ulmer's monograph. The intention here is to provide a brief view of the findings, and to introduce the reader to an intriguing account of long-term movements in capital and output in an important and distinctive sector of our economy. Even a brief glance at the discussion will reveal the variety of analytical suggestions advanced to account for the findings; and skimming through the appendixes will indicate the time-consuming effort that has been made to organize the underlying statistical data. One can trust that the data, findings, and hypotheses will be quickly absorbed in the stream of current work and thinking on economic problems; and thereby contribute to more reasoned views of them and so, hopefully, to more intelligent solutions.

PREFACE

THIS study grew out of a general inquiry into the secular growth of capital undertaken by the National Bureau of Economic Research in 1950. It was made possible by a generous grant from the Life Insurance Association of America.

It is a pleasure to acknowledge, and express gratitude for, the many debts incurred in the course of this study. The manuscript was read by Moses Abramovitz, Solomon Fabricant, Michael Gort, Simon Kuznets, and Geoffrey H. Moore, all of whom offered valuable suggestions. Periodic meetings during the planning stages made possible a fruitful exchange of views, also, with Morris A. Copeland, Daniel Creamer, Raymond W. Goldsmith, Leo Grebler, and Alvin S. Tostlebe. I had the benefit of useful comments from several Directors of the National Bureau—M. G. de Chazeau, Oswald W. Knauth, and Harold F. Williamson. In the extensive preliminary task of constructing statistical estimates, I was fortunate to have the competent assistance of Celia Gody. Milton Abelson and John Coleman also contributed to the statistical work in its earlier stages. I am grateful, also, for the skillful draftsmanship and imagination of H. Irving Forman, who prepared the charts, and for the editorial assistance of Mary Phelps and Emilie M. Hatfield. As with any strenuous and sustained effort, the sympathetic support of one's family and friends is vital. I acknowledge that in this regard my wife and children performed with extraordinary forbearance.

All the authors of the monographs in this series had the benefit of the aid of the Advisory Committee on the Study of Capital Formation and Financing, which assisted in drafting plans for the over-all inquiry and reviewed the final manuscripts. The committee was composed of Leo Wolman, Chairman; Sherwin C. Badger, Donald R. Belcher, Claude L. Benner, Percival F. Brundage, Arthur F. Burns, W. Braddock Hickman, Edgar M. Hoover, DeLong H. Monohan, and Geoffrey H. Moore.

MELVILLE J. ULMER

Gilmanton, I.W.
New Hampshire

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CAPITAL IN TRANSPORTATION, COMMUNICATIONS, AND PUBLIC UTILITIES: ITS FORMATION AND FINANCING

CHAPTER 1

The Background

THIS study is an essay in the new and swiftly burgeoning field of growth economics. It is a localized analysis, focusing upon one important aspect of the American economy—the long-range behavior of capital formation and financing in transportation, communications, and public utilities. Of course, it is hoped that some of our findings will have significance beyond this framework—that they will illuminate, to some extent, the phenomena of industrial growth in the American economy generally, and, to at least a sparing degree, in the world at large. Our objective is nonetheless specific. The segment of the economy with which we are concerned is of obvious importance in itself. Taken together, the industries involved have in recent years accounted for nearly one-third of the gross capital expenditures on plant and equipment by private nonagricultural industry in the nation as a whole. In the earlier years within our purview their relative importance was even greater. They represent, also, an industrial area in which the degree of public regulation is sufficiently higher than elsewhere, in general, to warrant special consideration. We shall begin by describing the plan of the study, some of the underlying concepts and definitions, the character of the industries reviewed, and the scope and nature of the statistical materials.

Framework and Objectives

The few particular theories which bear upon long-term developments are discussed in the body of the text, as (and if) their applications arise. They will not be reviewed here. But a few prefatory remarks seem in order at this point on the underlying conception of secular development which enters our analysis. And this, fundamentally, turns on what we are trying to find out.

In one respect, this study springs from an interest in the long-run future. What are the prospects for capital formation over the next several decades? To what extent, and in what form, will they be reflected in financial markets? No illusions are entertained concerning the degree of reliability of any answers which may be made to these questions. For one thing, complete answers can be framed only on the basis of considerations which far transcend the ordinary borders of economic inquiry—entering into such disciplines as political science, international relations, and sociological history. Even within economics, the uncertainties faced are overwhelming.

But this is not the same as saying that *nothing* may be said, on the basis of economic analysis, about the future. It is, we think, not too much to hope for conditional statements about future trends (rather than prophecies) of practical interest to economists and men of affairs in politics and business.

But totally aside from this, an interest in the future provides a particularly fecund approach to a study of the past. Especially in fields in which formalized theory is scanty, it aids in lending purpose to description and discrimination to the accumulation of facts. It obviously heightens the need for hypothesizing and probing historical relationships, and for distinguishing the more enduring patterns from the primarily fortuitous.

TYPES OF PATTERNS

Indeed, patterns of uniformity in past behavior must comprise the central foundation for an appraisal of the future, and their analysis necessarily occupies a considerable portion of this study. Such patterns are of two general kinds. The first of these may be termed the *sequential pattern*, which refers to uniformity in the nature of the temporal sequence of events in single series of the same general classification. One of the best examples of a sequential pattern is the logistic curve, found by Pearl to be characteristic of growth in the populations of certain organisms under given conditions,[1] and used extensively by Kuznets to describe the growth of production.[2] But a sequential pattern need not be of mathematical form. Indeed the application of mathematical equations to sequential patterns have been, for the most part, deliberately eschewed in the body of this work. Few, if any, of the trends we have defined are sufficiently distinct, or sufficiently simple, to justify their use. And yet much can be said in quantitative terms, without formal mathematics, concerning the directions in which series move, the pace at which they progress, and the comparative behavior of different series of the same general kind or of any given series at different stages of development. To attempt to caparison all in a neat mathematical "law" would grossly violate the complexity and volatility of the multitude of forces which, in fact, act upon capital formation.

But a sequential pattern is essentially a relationship between the

[1] Raymond Pearl, *The Biology of Population Growth* (Knopf, 1925). Pearl and L. J. Reed applied the curve to the human population in their study, "On the Rate of Growth of the Population of the United States since 1790 and its Mathematical Representation," *Proceedings of the National Academy of Sciences*, Vol. 6, 1920, pp. 275–288. For an application of the curve to the population of business firms see Melville J. Ulmer, "Industrial Patterns of the Business Population," *Survey of Current Business*, May 1948, pp. 10–15.

[2] Simon Kuznets, *Secular Movements in Production and Prices* (Houghton, Mifflin, 1930).

variable of interest and time. No matter how broadly or narrowly defined, it is limited to purely descriptive services unless underlying economic factors, operating over time, are at least to some extent exposed. Whether the pattern may be extrapolated can be judged only by a study of the forces by which it was molded, and by the likelihood of their persistence. Often the underlying forces are susceptible to qualitative study only. But in some cases they may be represented quantitatively. Under these circumstances the possibility arises of defining quantitative relationships between the variable of principal interest and affiliated ones. Such relationships may be termed *affinitive patterns*. For example, the volume of residential housing may be related to such variables as changes in population, income, and interest rates.

A study of long-term trends, when most fruitful, yields uniformities or patterns, both of the sequential and affinitive variety. And a search for patterns and underlying forces obviously requires guides in the form of hypotheses and theories. In this regard, as already suggested, the store of available tools is far from abundant. For example, static theory suggests a relationship between the volume of investment, the prospective rate of return over costs, and the cost of money capital. But in seeking long-run determinants of investment, or of the methods by which they are financed, explorations inevitably move beyond this framework. We must inquire generally into the factors which generate enduring changes in the prospective rate of return, and are led to investigate long-run changes in the stock of capital, technological innovations, trends in the capital-product ratio, the role of population, tastes, urbanization, shifts in competition, and the like. The direction in which these factors *may* operate is in most cases obvious. But beyond this—the extent to which such forces *have* influenced investment over time, the relative importance of each, the directions in which they are tending—little can be said before examination of the facts. And in the realm of finance, in seeking shifts in the sources of funds, we must similarly rest on a loose and flexible system of ideas which only a background of factual study can reinforce and amplify.

THE TIME FACTOR

How to define the long run! Is it not, after all, merely the sum of its parts? And just when does the successive summation of short runs add to a total which may be termed long?

We shall think of the long run as any movement which persists over the course of more than one business cycle. For example, if one business cycle develops at a higher level than the previous cycle,

we shall consider this a long-run upward movement. This view is premised on the observation that certain underlying economic forces generate movements which, in fact, do persist over the course of more than one (and often many) business cycles. An obvious illustration is the phenomenon of "linked" innovations.[3] The invention of the steam engine led to new modes of production in a multitude of industries to which its employment was adapted, to additional innovations in rail and water transport, in metallurgy, shipbuilding, coal mining, the construction of harbors, and so on. The development of a transcontinental railroad system was itself the initial link in a chain of innovations leading to the opening of new regions, to the appearance of new products, and new alignments of industry and distribution. Trends attributable to such cumulative innovation patterns are, by any standard, long-run.

There are others which we shall consider within our purview, in accord with the definition cited, though their classification may not be quite so distinct or unequivocal. Such is the twenty-year building cycle. The possibility of similar movements in the capital formation of regulated industries is a matter which receives some attention in subsequent pages. Their potential importance in the development of the regulated industries is such as to compel their inclusion. Furthermore, no statement of possible practical interest about the future (say the probable level of capital formation in the decade of the 1960's or 1970's) can afford to neglect the possible significance of waves of this kind.

But the business cycle is considered beyond the scope of this study. Though on occasion we may note the implications of our observations for such "short-run" phenomena, and though in many places we shall have to take them into account, they shall not be considered an object of the present study.

Characteristics of the Industries

In most industrial classifications the segment of the economy included in this study would be covered by the phrase, transportation, communications, and electric and gas utilities. For brevity, we shall refer to our group throughout this volume as the "regulated" industries. This is a matter of convenience, although it also serves to call attention to one of their more important characteristics. In our group, social control of business activity is generally more traditional and more extensive than elsewhere in the economy. Among the branches of industry we *exclude*, the most closely

[3] See B. S. Keirstead, *The Theory of Economic Change* (Macmillan, 1948), p. 136.

approaching in this respect are probably finance, agriculture, and housing.

The regulated industries, as we have circumscribed them, do not quite coincide with the segment of the economy covered by the legal definition of public utilities. Our concept is slightly broader. A few of the smaller components we include, such as radio broadcasting, have been denied public utility status by the courts. However, the legal concept does cover the more important industries in our group, and the others are at the very border of public utility status —at least when judged by the very high degree of government regulation now accorded legal approval.

One prominent characteristic of the regulated industries is a relatively high degree of monopoly. This, to be sure, is not *universally* true. There are minor exceptions, such as taxicab service, which is included in our group along with other types of transportation. But, generally speaking, the regulated industries are monopolistic, and it is this factor, when coupled with others, which most often justifies the public control exercised over their activities. In many cases, the companies in the various segments of our group operate under franchises, which confer exclusive rights for providing particular types of service in restricted areas. This is true, for example, of electric light and power, railroads, and telephone companies. In no case, of course, is the degree of monopoly unlimited. Obviously, the several types of transportation, of power supply and communication, compete. But in many cases, as in the provision of power for illumination in a particular locality, or the long distance hauling of coal in bulk along certain routes, the practical degree of monopoly enjoyed is very high.

All the regulated industries operate either under franchises or under licenses. Along with the exclusive rights they provide, franchises entail a threefold duty of serving all who apply, at "reasonable" rates, without discrimination. The granting of franchises thus implies some degree of public control over both investment and disinvestment. But it is important to note that this is tenuous and indirect, at most. The acceptance of a franchise by a private company is itself a voluntary act. And once accepted, only a minimum amount of service becomes mandatory. Facilities may be built with a level far above the minimum in mind, and later may be substantially contracted—all without public intervention. Considerable latitude ordinarily exists in the quality of the service performed and in the manner of its production. Furthermore, franchises may be abandoned.

Licenses are of course not so binding as franchises. Typically, the

rights are not exclusive, and no obligation for the provision of service is entailed. Both licenses and franchises are associated with public regulation. The principal industries in the regulated group—e.g., the railroads, electric and gas utilities, telephones, street railways, and bus companies—operate on franchises and are subject to government regulation of the prices charged for their services.

The regulated industries are in many respects characterized by great diversity. Though it is of interest to deal with their totality—as we do in subsequent pages—the distinctive attributes of individual components can at no time be overlooked. To subject each component to detailed statistical analysis, however, is a task which would require more time—and space—than could be devoted to this study. Accordingly, a compromise was achieved. All statistical data have been provided for the sum of all regulated industries as a group and for six components: the railroads, electric light and power, telephones, local bus lines, street and electric railways, and "all other" regulated industries. These industries were selected because of their quantitative importance—now or historically—and because of the widely different stages of development they represent.

It should be borne in mind that the regulated industries are privately owned and operated. Our analysis, therefore, does not include the growth of public power facilities, publicly owned municipal transportation systems, or other public projects, except insofar as it must be taken into account when appraising the behavior of private business in the same or related fields. Our basic statistical series, unless otherwise indicated, cover private operations alone. A study of publicly owned projects would obviously have introduced a wide variety of special elements to our analysis, springing from the different motivations and the different conditions shaping the development of such enterprises. Their activities are worthy of a separate study.

The Data

It is a commentary on the paucity of our knowledge of long-term growth, that *not one* of the series employed in this study was heretofore available in its entirety. Accordingly, much of the time devoted to this project was concerned with the construction of the statistical foundation. New annual series from 1870 through 1950 are presented herein for the totality of the regulated industries and for each of the six segregated components on gross capital formation, capital consumption, net capital formation, and the aggregate value of plant and equipment. They are presented both in current and in 1929 dollars. Of these, only fragmentary figures on gross capital

expenditures in current dollars were previously available, covering some of the recent years for some of our components. In addition, data on the output of the regulated industries—in the aggregate and for components—are presented in 1929 dollars for the period from 1880 through 1950. For the latter series, however, considerable groundwork had been laid by the earlier measurements of Gould[4] and Barger,[5] who, between them, covered most of the regulated industries and most of the time period of interest.

A word is in order here concerning the nature of these data, although full descriptions of their characteristics and their derivation are provided in Appendixes A through I. In general, the degree of their accuracy is directly correlated with time. For the years prior to World War I, in particular, the annual figures are subject to a considerable margin of error. There is, however, no evidence of any consistent bias, and tests suggest that moving averages succeed in eliminating, i.e. smoothing, most of the error in the estimates for the earlier years, as indicated in Appendix A. Accordingly, our analysis has been confined to a study of the nine-year moving averages, which prove to be a sufficiently sensitive tool for the object in hand of illuminating long-term trends.

Except for Chapter 8, in which explicit attention is given to financial relationships, analysis is focused entirely upon "real" quantities. Gross and net capital formation refer to flows of expenditures measured always in terms of the prices prevailing in 1929—and in this sense may be interpreted as physical quantities. Capital consumption and the stock of capital are similarly measured in dollars of constant purchasing power. This, of course, is a necessary procedure where the intent is to explore the characteristics and causes of growth, for the essential features of the phenomena under review would remain hopelessly obscure unless the influence of price level changes were segregated. On the other hand, when problems of financing are raised, as in Chapter 8, the analysis is extended to the flows of money capital unadjusted for alterations in purchasing power.

For the same reasons, output is likewise measured in "physical" terms. Thus railroad output refers to quantities of freight ton-miles and passenger miles, appropriately weighted; electric light and power, to units of electrical energy sold, weighted in accord with type of consumer; telephone output, to the weighted number of

[4] J. M. Gould, *Output and Productivity in the Electric and Gas Utilities, 1899–1942* (National Bureau of Economic Research, 1946).

[5] Harold Barger, *The Transportation Industries, 1889–1946* (National Bureau of Economic Research, 1951).

local and toll calls, and so on. To provide comparability with our measures of capital formation, the output series were valued at 1929 prices, and hence are similarly expressed in terms of money of constant purchasing power. Of course, measures of the physical quantity of capital formation as well as of output are subject to a common bias, inherent in *all* estimates of this kind. They do not reflect alterations in the *quality* of goods and services over time. In this sense, since the trend of quality has been upward, our figures understate the growth of capital and of output. A departure from the purely quantitative concepts employed, however, is neither feasible nor necessarily desirable.[6]

Certain peculiarities of definition in our series may be noted. Capital formation (whether net or gross) refers to accumulations of plant and equipment; the stock of physical reproducible capital similarly refers to the value (in constant dollars) of plant and equipment. The point is that inventory accumulations are consistently omitted from our series—a procedure justified by the fact that inventory accumulation is a matter of distinctly minor consequence among the regulated industries. Over the long run in this segment of the economy not more than 2 per cent of all money capital, and probably considerably less, was used for this purpose. On the other hand, the statistical resources available for estimating inventory trends are scanty over the period of interest; it was felt that the time required for constructing such estimates would not be warranted in the light of their negligible quantitative importance. It should be noted also that our figures on capital formation exclude land. Although for brevity the word is often omitted, our reference throughout this volume is to *reproducible* capital. Only in Chapter 8, where we focus on money flows and financing, do we consider expenditures on land and on inventories.

Our series on output are gross measures, in that they represent the *total* volume of goods and services produced. No deduction is made for the materials *consumed* in their production, which were purchased from other branches of industry. An analysis of the relevant data shows that the trend of output would be about the same whether measured in gross or in net terms.[7] Where the

[6] A passenger mile today may be a much more comfortable one than fifty years ago. *How* much more, could be measured only in terms of some unit of consumer satisfaction or utility. But the satisfaction actually experienced by a consumer would depend also on (among other things) the alternatives available now and fifty years ago, and these were very different. Neither the meaning of, nor a general way of measuring, a qualitative change is entirely clear. Considerations of much the same kind apply to qualitative changes in capital goods.

[7] See discussion in Chapter 4 in the section on *The Data*.

distinction in concept is significant for other purposes, at later points, particular attention is called to the matter and, where necessary, appropriate adjustments made.

In the next two chapters we shall review the record of the regulated industries, employing all of these data. Our discussion in these chapters, and to a large extent in Chapter 4 as well, will remain primarily on the descriptive level, laying the necessary groundwork for the analysis undertaken later.

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.

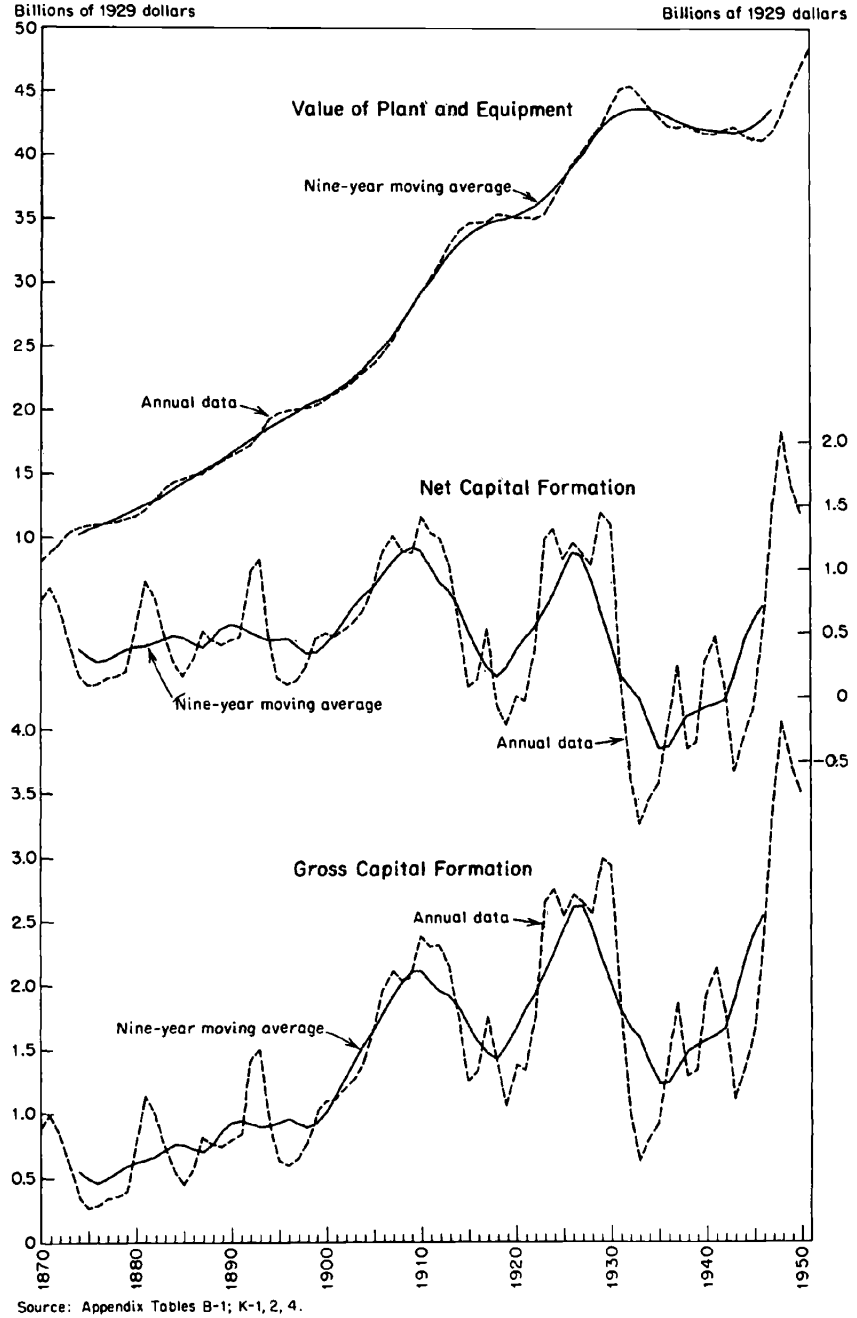
The net result of the growth of the regulated industries is reflected in the expanding volume of their total stock of plant and equipment, depicted in the top panel of Chart 1. Physical capital exclusive of land, and measured in 1929 dollars, aggregated about $8 billion in 1870; by 1889 it amounted to $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

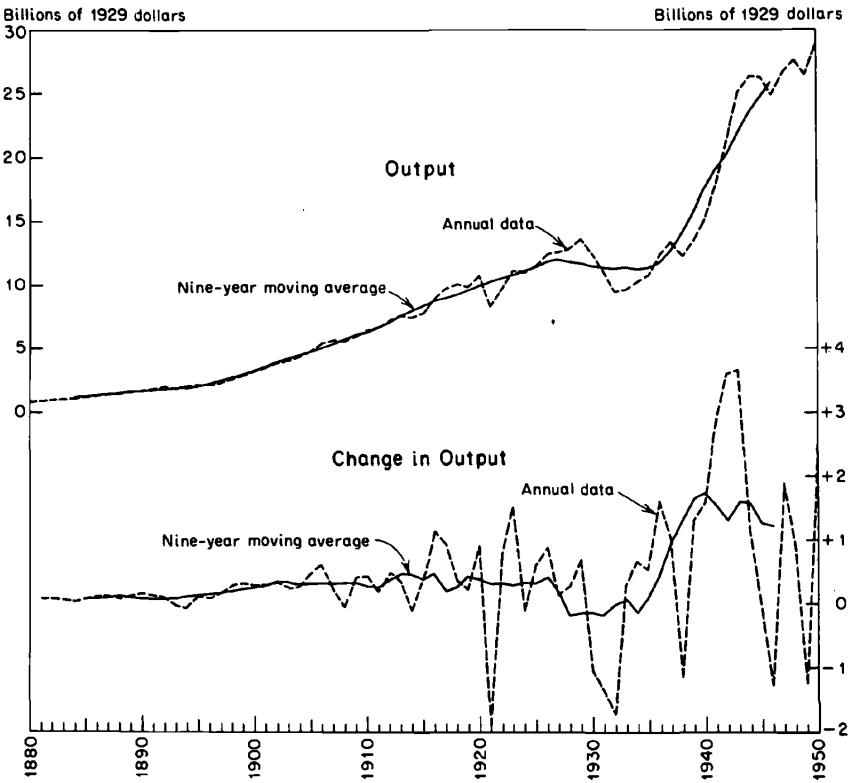
[a] Terminal date in nine-year moving average series.

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

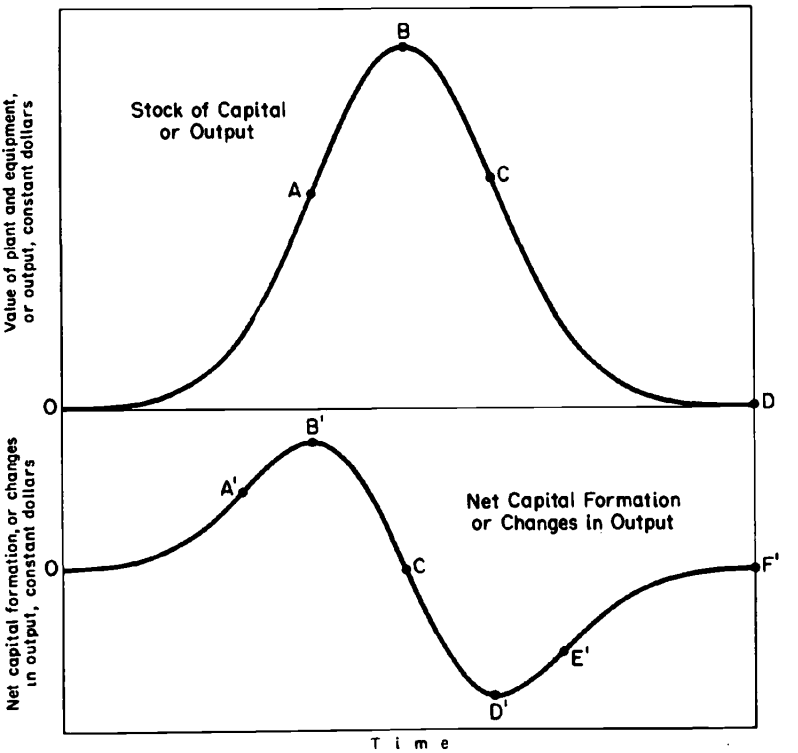
The considerations above suggest a familiar pattern of growth, to which attention may be called at this point. Not only the totality of all regulated industries, but also each of the selected individual components, discussed in the next chapter, appear to conform—at least roughly—to this pattern. For 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).

CHAPTER 3

Variations in Secular Patterns

IN at least one respect the utilities group is far from cohesive. It includes industries in widely diverse stages of development—from the venerability of the steam railroads to the robust middle age of electric light and power and the swiftly growing adolescence of pipe lines and air transportation. Stage of development is of course not a mere matter of chronology, for there is great variety in life spans, and maturity arrives much more quickly for some than for others. This will be apparent when we apply to their growth trends, the model pattern of secular development introduced in Chapter 2, and note the progress made by each of the components.

As indicated earlier, the individual regulated industries we have selected for special study were chosen—at least in part—with an eye to the proper representation of this heterogeneity. The components so selected are listed in Table 7, where the relative importance of each with respect to the stock of reproducible capital and capital formation is also given.

The preponderant share of steam railroads in the total during the first decade of our time span is clearly evident in this table.[1] By the early 1900's, however, this situation had been substantially altered. The proportion of the total physical stock of capital held by the railroads declined from nearly 85 to less than 70 per cent; their share of gross capital formation declined from about 82 to less than 45 per cent, and their share in net capital formation from more than 80 to less than 40 per cent.

The industries which had made the most significant relative gains from the 1870's to the 1900's were street and electric railways and electric light and power. The growth of both, of course, reflected the quick spread of the commercial application of electricity. The former in the first decade of the twentieth century accounted for 12 per cent of the constant dollar value of plant and equipment, and for about 20 per cent of the total capital formation of all regulated industries. Electric light and power—a much younger industry—accounted for less than 5 per cent of the stock of reproducible capital, but for more than 15 per cent of the total capital flow. Telephones had also made substantial gains. The all other group—roughly—maintained its relative position.

[1] Note that the term steam railroads is used loosely here and throughout this volume; it covers roads which in the modern era have used diesel or electric power as well as steam. We use the term because of its historical importance, and also to assist in avoiding confusion with the electric street railways prominent in urban transportation.

TABLE 7

Percentage of Total for All Regulated Industries Accounted for by Each Component in Stock of Reproducible Capital and Capital Formation, Selected Decades

(*based on values in 1929 dollars*)

Industry	*1870–1879*	*1900–1909*	*1940–1949*
	VALUE OF PLANT AND EQUIPMENT		
Steam railroads	84.8	67.4	52.7
Electric light and power[a]	0	4.6	17.4
Telephones	0	3.1	7.0
Street and electric railways[a]	1.5	12.2	2.7
Local bus lines[a]	0	0	0.8
All other transportation, communications, and utilities	13.7	12.7	19.5
Total	100.0	100.0	100.0
	NET CAPITAL FORMATION		
Steam railroads	80.7	39.1	3.8
Electric light and power[a]	0	17.8	30.0
Telephones	0.3	8.1	41.6
Street and electric railways[a]	3.6	20.9	−9.3
Local bus lines[a]	0	0	2.4
All other transportation, communications, and utilities	15.4	14.0	31.6
Total	100.0	100.0	100.0
	GROSS CAPITAL FORMATION		
Steam railroads	81.7	44.1	23.8
Electric light and power[a]	0	15.1	22.0
Telephones	0.2	9.4	20.3
Street and electric railways[a]	3.6	18.1	1.1
Local bus lines[a]	0	0	2.5
All other transportation, communications, and utilities	14.6	13.3	30.3
Total	100.0	100.0	100.0

[a] Excludes publicly owned facilities.

Source: Appendix Tables B–1, C–1, D–1, E–1, F–1, G–1, and H–1. Detail may not add to 100 because of rounding.

By the 1940's further significant revisions had occurred in the relative importance of the principal regulated industries. Telephones exceeded all other components in net capital formation, accounting for about 40 per cent. Electric light and power and the all other group—reflecting the growth of pipe lines, gas utilities, trucking, air transportation, and other new industries—were not far behind with about 30 per cent each of the total net capital formation. The railroads' share in the net flow of capital had been reduced to less than 4 per cent. It is important to note, however, that the railroads still—in the 1940's—owned more than half the reproducible capital of all regulated industries and, because of the large replacement

demand stemming from this ownership, accounted for a significant proportion of the total gross capital formation. Of course street and electric railways were actually contracting in this period. Local bus lines were growing, but accounted for only a modest share of the total investment flow.

The relative importance of each of the components in terms of output (as measured by the constant dollar value of their services) is shown in Table 8. The share of the railroads in this total declined

TABLE 8

Percentage of Total for All Regulated Industries Accounted for by Each Component in Output

(*based on nine-year averages of values in 1929 dollars*)

Central Year in Nine-Year Average	*All Regulated Industries*	*Railroads*	*Electric Light and Power*	*Telephones*	*Street and Electric Railways*	*Local Bus Lines*	*All Other*
1886	100	80	...	...	...	0	...
1890	100	80	...	...	...	0	...
1896	100	77	1	2	9	0	11
1900	100	74	2	3	9	0	12
1906	100	68	2	6	10	0	13
1910	100	66	3	7	10	0	14
1916	100	64	5	7	9	0	15
1920	100	60	7	7	9	0	16
1926	100	52	11	9	8	1	19
1930	100	45	15	9	6	1	23
1936	100	37	19	9	5	2	28
1940	100	41	19	8	3	2	27
1946	100	38	20	8	2	2	30

Detail may not add to 100 because of rounding.
Source: Appendix Table K–9.

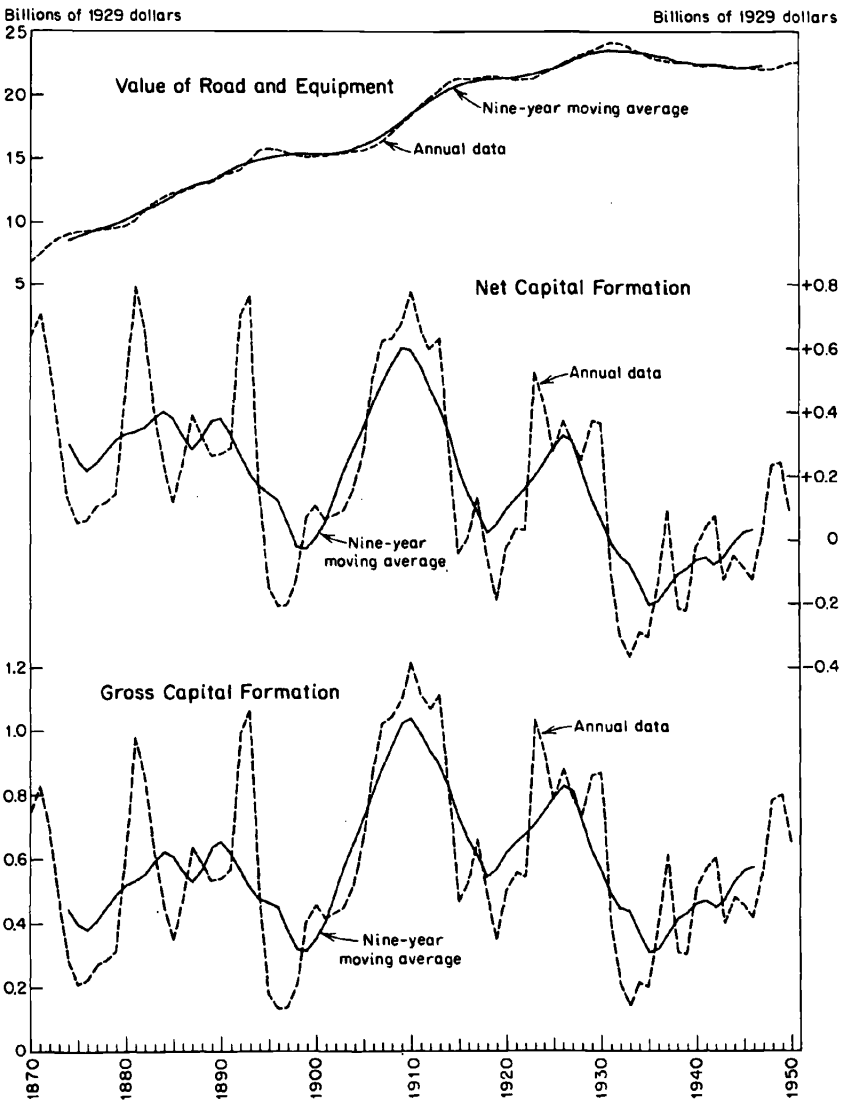
sharply from 1896 to 1946, though at the latter date they still accounted for nearly 40 per cent of the production of all regulated industries. Street and electric railways, which had once accounted for 10 per cent, had dropped to 2 in the 1940's. Aside from the all other group, the second most important in the 1940's, in terms of production, was electric light and power with 20 per cent. Telephones had also achieved a relative standing of significance, with 8 per cent of total output. The all other group, with its many new and widely publicized segments, accounted for 30 per cent.

Capital Flows

The rate of growth of the various components is shown in the center panels of Charts 4 through 9. The diversity of behavior is

CHART 4

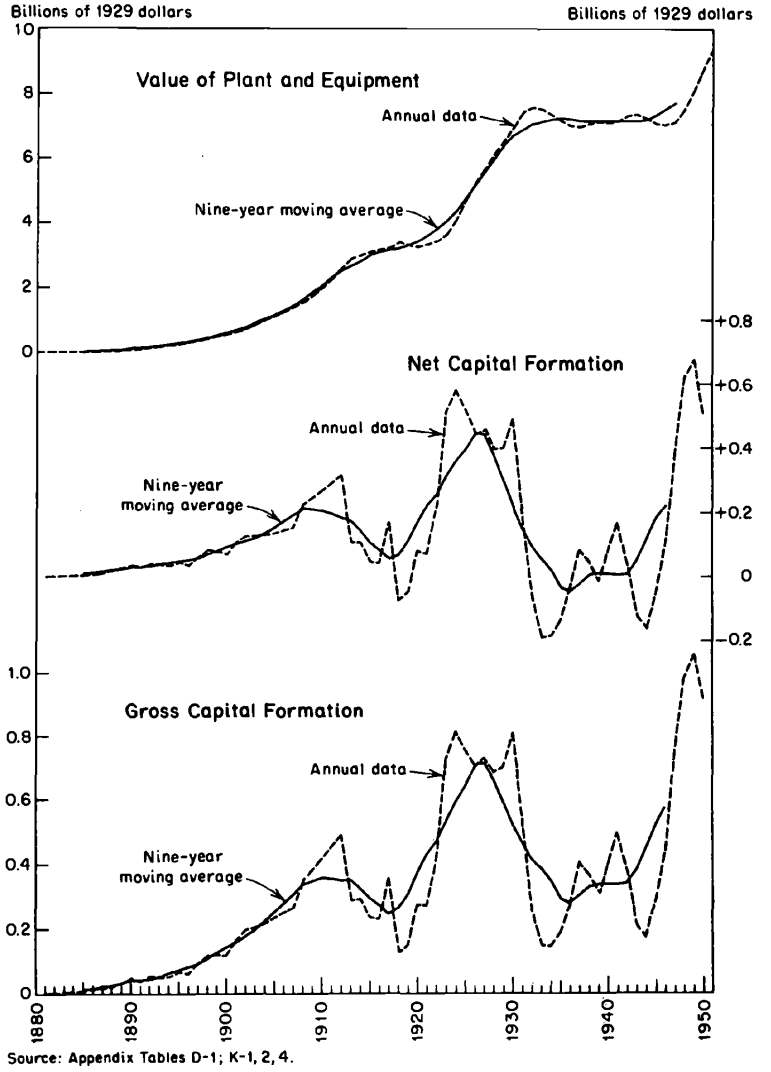
Value of Road and Equipment and Capital Formation, Steam Railroads, 1929 Dollars, 1870–1951



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

CHART 5

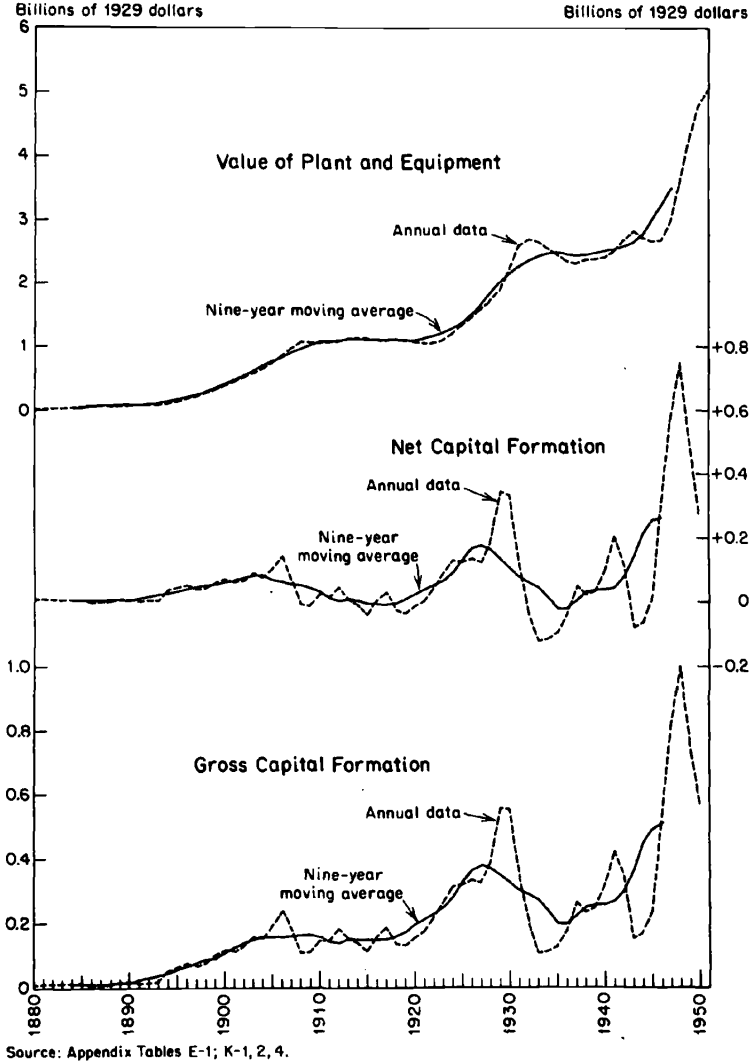
Value of Plant and Equipment and Capital Formation, Electric Light and Power, 1929 Dollars, 1881–1951



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

CHART 6

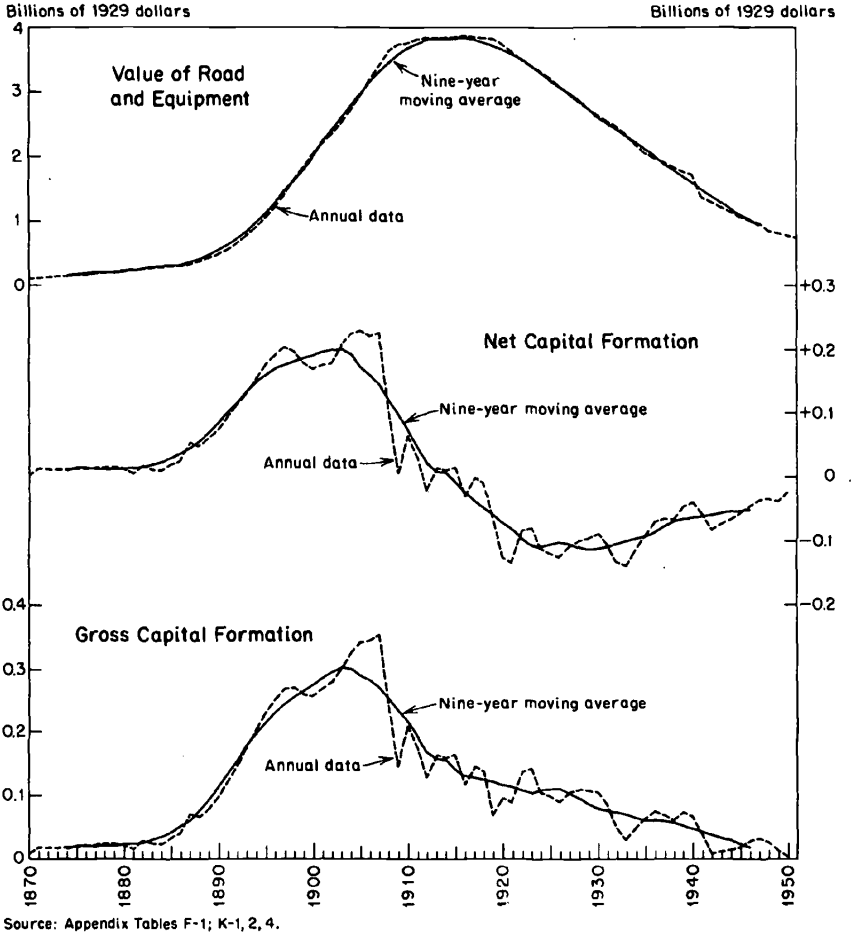
Value of Plant and Equipment and Capital Formation, Telephones, 1929 Dollars, 1880–1951



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

CHART 7

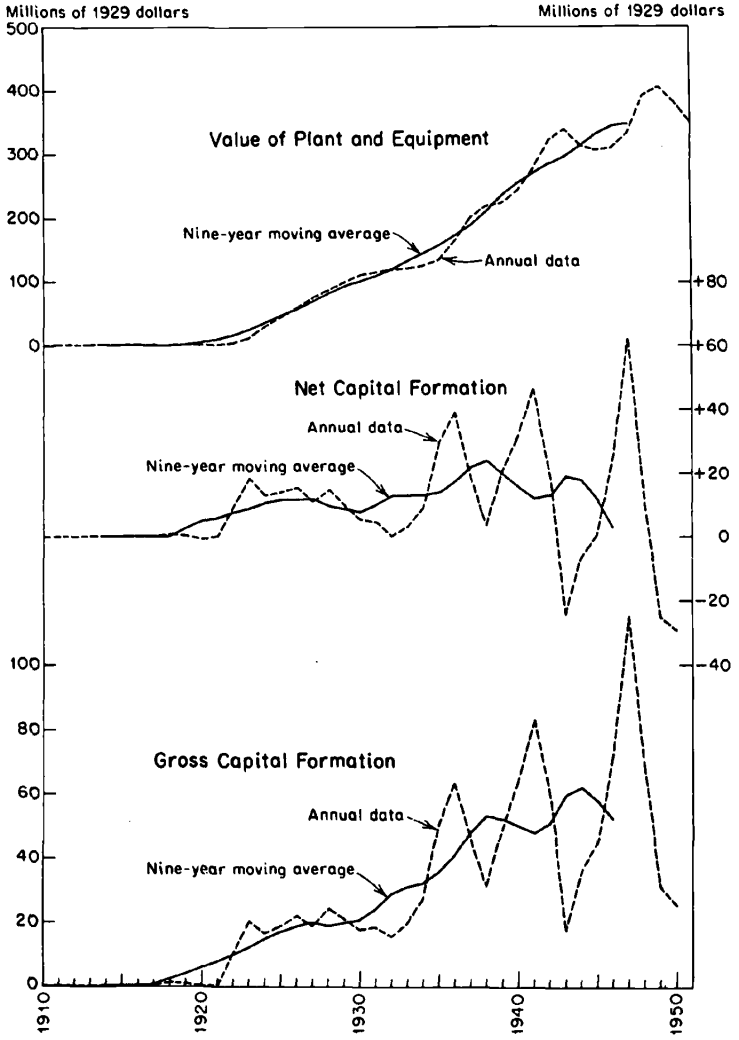
Value of Road and Equipment and Capital Formation, Street and Electric Railways, 1929 Dollars, 1870–1951



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

CHART 8

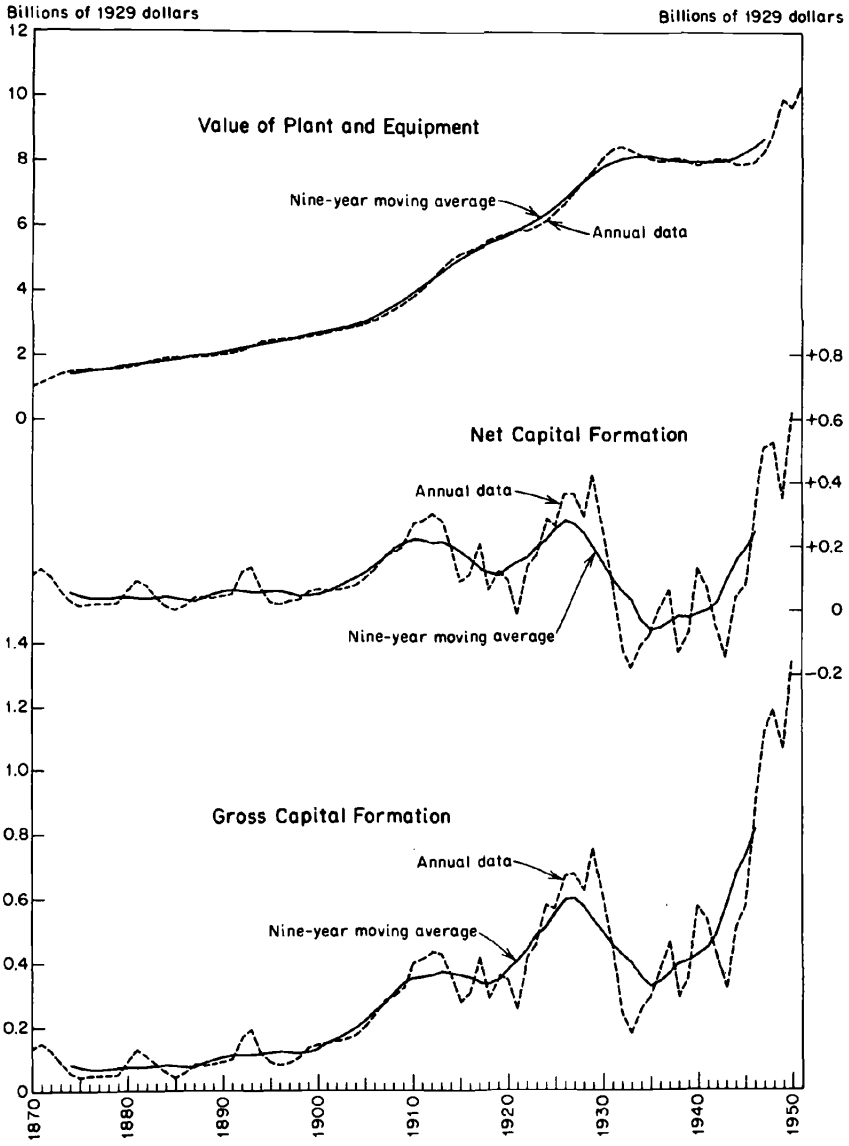
Value of Plant and Equipment and Capital Formation, Local Bus Lines, 1929 Dollars, 1910–1951



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

CHART 9

Value of Plant and Equipment and Capital Formation, All Other Utilities and Transportation, 1929 Dollars, 1870–1951



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