THE CAMBRIDGE ECONOMIC HISTORY OF THE UNITED STATES

VOLUME III

The Twentieth Century

Edited by

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PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UK http://www.cup.cam.ac.uk
40 West 20th Street, New York, NY 10011-4211, USA http://www.cup.org
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

Ruiz de Alarcón 13, 28014 Madrid, Spain

First published 2000

Printed in the United States of America

Typeface Garamond 11/13 pt. *System* QuarkXPress [BTS]

A catalog record for this book is available from the British Library.

Library of Congress Cataloging in Publication Data available
ISBN 0 521 55308 3 hardback

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AMERICAN MACROECONOMIC GROWTH IN THE ERA OF KNOWLEDGE-BASED PROGRESS: THE LONG-RUN PERSPECTIVE

MOSES ABRAMOVITZ AND PAUL A. DAVID

OVERVIEW AND ORGANIZATION OF THE CHAPTER

This chapter focuses on the nature of the macroeconomic growth process that has characterized the United States experience, and manifested itself in the changing pace and sources of the rise of real output per capita in the U.S. economy during the past two hundred years. Our main interest is, indeed, in the twentieth century, but we believe that its major characteristics and the nature of the underlying forces at work are most clearly seen in comparisons between the century just past and the one that came before.

A key observation that emerges from the long-term quantitative economic record is that the proximate sources of increases in real gross domestic product per capita in the century between 1889 and 1989 were quite different from those which obtained during the first one hundred years of the American national experience. Baldly put, the national ecomomy moved from an extensive to an increasingly intensive mode of growth, and its development at the intensive margin has become more and more dependent upon the acquisition and exploitation of technological and organizational knowledge.

Our first objective, therefore, must be to assemble and describe the components of the U.S. macroeconomic record in some quantitative detail, in a manner that exposes the nature and dimensions of the contrast between the nineteenth and twentieth centuries. We approach this task within the well-established framework of "growth accounting." This enables us to show the secular acceleration that occurred in the growth rate of total

factor productivity, which is the weighted average of the productivities of capital and labor, and the growth in the importance of total factor productivity as a source of labor productivity and per capita output increases. Further, by taking account of changes in the quality of the productive inputs, we arrive at "refined" measures of total factor productivity growth, which highlight two contrasts between the eras preceding and following the transitional decades, 1879–1909.

The first of these is the enlargement of that element in the long-term growth rate of labor productivity that remains unexplained by the factor inputs we can measure and thus is associated, but not identical, with advances in technological knowledge – including the knowledge permitting realization of economies of large scale production. The second major contrast between the nineteenth and twentieth centuries is the diminished relative importance of conventional tangible capital accumulation in the twentieth century and the rising role of intangible capital formation through investments in education and training, on the one hand, and the organized investment in research and development (R&D) on the other.

After the turn into the twentieth century, the substitution of fixed capital for labor was governed by conflicting forces. It was strengthened for many decades by slower growth of labor supply and a concomitant tendency for wages to rise more substantially than they would otherwise have done. These developments stemmed in part from demographic changes, including the immigration restrictions following World War I, in part from the downward trend in hours of work and in part from the lengthening years of education. At the same time, there were also important new opportunities to reduce costs by developing methods of intensifying the utilization of fixed facilities.

This was a strategy that was first implemented in the late nineteenth and early twentieth century by consolidation of railroads, by the technological innovations designed to increase train speeds and power utilization, and by the growth of continuous process industries, notably petroleum extraction, transport, and refining, and its extension to petrochemicals. Its roots also can be found, as Alfred Chandler, Jr. has pointed out, in the high throughput manufacturing regimes that appeared after 1870 when production and direct-selling by manufacturers were extended to serve increasingly wide markets.

The challenges of operating greatly enlarged technological and commercial systems on a continental scale contributed to the rising demand

for a more formally educated breed of managers, as well as workers with higher levels of literacy and numeracy. They also called forth new control technologies, which played a role in initiating the pioneering U.S. advances in communications and information technologies, beginning with the telegraph system's close relationship to railroad operations in the mid-nineteenth century, and leading on to the development of the telephone system, and the computer systems of the twentieth century.

Thus, however distinct and different was the new technological spirit of the twentieth century, we may see that the way in which a succession of general-purpose technologies came to be elaborated and implemented in the United States during the twentieth century – how electricity, telecommunications, the gasoline-powered internal combustion engine, and, most recently, the digital computer have reflected the interplay of global developments that were expressed, first and most fully, in American circumstances, and so took forms that owed much to the particular legacy of America's nineteenth-century development.

Our second purpose, therefore, is to advance an interpretation of the forces underlying the ascent of the U.S. economy to its internationally dominant position in the twentieth century, and to account for the transformations that have occurred in the relationships among the proximate sources of America's macroeconomic growth. The principal elements of our interpretation can be identified under two headings. First are those forces that can best be regarded as generic, global tendencies, linked to internationally shared advances in science and technology broadly construed. The emergence of new and greater potentiality for knowledge-based economic development during the twentieth century, and the working out of its implications for production methods and the endogenous growth of productive resources in the context of the United States, is thus to be understood not as a unique, national phenomenon. Rather, these form part of a much broader set of tendencies, far more global in their ultimate manifestations, which took an early and particularistic form in the American setting.

We read the available evidence as indicating that the overall bias of innovation during the nineteenth century was strongest in the direction of labor-saving changes; that the latter were not only relatively more pronounced than the tendency towards natural resource-saving, but were markedly stronger than the impacts on use relative to usage of tangible reproducible capital-inputs. Indeed, we contend that technological progress in the nineteenth century was characterized by an absolute *capital-*

using bias.[1] By contrast, from the experience of the U.S. macroeconomy it appears that the twentieth century has been characterized by a bias towards innovation of an *intangible* capital-using kind, and the emergence of tangible capital-saving technical change alongside ordinary labor-saving innovation – albeit with a bias in favor of the latter that represents a continuation of what had been experienced in the preceding century.

Among the second broad category of forces are some that may be held to constitute more specifically American national characteristics, conditions which at the opening of the present century properly could be viewed, and were cited by contemporaries as responsible for the differences they perceived between the ways that production and distribution were organized and conducted in the U.S., compared with the economic practices prevalent in the Old World. Some of these had their roots in the trajectories of resource exploitation and technological adaptations that were established previously, during the extensive developmental phase of the preceding era. Others certainly reflected features of the socio-economic structure, political institutions, and cultural ethos that were peculiar to or most prominently displayed by the young society that had taken shape in this region of recent European settlement. The ways in which the technologically driven demand-side forces in the factor markets elicited the supply-side responses necessary for the formation of new, and non-conventional, stocks of intangible capital, and the specific demographic and institutional developments that also contributed to shifting factor supply conditions to account for the salient features distinguishing the U.S. growth path in the twentieth century from the preceding course of macroeconomic development. Nevertheless, in the continuing accumulation of capital at a pace which has exceeded the rate of growth of output, the long-run dynamics of the contemporary economy displays an important element of continuity with its past experience.

Third, we turn from the U.S. growth performance in the twentieth century to that of the preceding epoch, and examine the American path of development in relation to the contemporaneous experiences of the other industrial nations. The twentieth century's opening half had witnessed the U.S. ascent to a position of international economic leadership in regard to the average level of real income enjoyed by members of the population. This, as will be seen, was based upon the early establishment and further

[1] Because the associated concepts are central to the interpretation advanced in this chapter, it is important at the outset that the terms "factor-saving" and "factor-using" should be understood to be defined relatively, i.e., in relation to output.

widening of the country's productivity lead vis-à-vis the other industrialized and industrializing nations. Consequently, the years immediately following World War II found the United States at the pinnacle of comparative affluence and preponderance in the international economy, a position that soon began to be eroded by the recovery of other, war-torn economies, and the emergence of strong tendencies among the industrial economies not only to converge in their levels of productivity but to "catch up" with the United States, and in some instances to forge ahead. These international perspectives on the American growth experience are developed more fully later, where we offer a broad account of the key forces that have worked to alter the economy's relative position on the global stage. A number of the important elements that had contributed to the creation of "American exceptionalism" in both the material and technological domains subsequently lost their former significance – having been either transformed at home, or come into existence more ubiquitously among the world's industrially advanced societies in the course of the twentieth century. Such developments, especially those that came to fruition in the post-World War II era, will be seen to help account for the modifications that have occurred in the U.S. position of industrial leadership.

A STATISTICAL PROFILE OF AMERICAN GROWTH SINCE 1800

Problems of Measurement

Output per head of a nation's population, said A. C. Pigou in a classic study, is the "objective, measurable counterpart of [its] economic welfare." Output per head is only part of the content of economic welfare, but it is with this in mind that we make the growth of per capita output the focus of this chapter. Our purpose here is two-fold: first, to draw a statistical picture of American growth and of the proximate elements or sources from which it derived; and, second, to search for the conditions or forces that controlled the strength of these elements and their changes. We identify the proximate sources of growth in the manner of John Stuart Mill:

> We may say, then, . . . that the requisites of production are Labour, Capital and Land. The increase of production, therefore, depends on the properties of these elements. It is the result of the increase either of the elements themselves, or of their productiveness." (*Principles of Political Economy*, Ashley Edition, 156)

We shall in the end search for the forces that lie behind the increase of the "elements" and their "productiveness." But our search is a limited one. It goes as far as our own understanding and the length of this chapter allow. We draw attention at this early point, therefore, to the deepest causes of growth that lie in America's attitudes and aspirations. in the institutions that govern the operation of the American economic system and in the incentives that support work, capital accumulation, enterprise and the advance of practical knowledge; but we cannot attempt a systematic exploration of these fundamental conditions. Our first task is simply descriptive.[2]

The growth with which we can deal with some degree of assurance is the growth as it appears in the available statistics. The growth rates of aggregate and per capita output that appear in the statistics are the growth that can be measured; with few exceptions that means the output that flows through commercial markets. Such measures are neither comprehensive nor unbiased. The goods and services that are produced in the home or on farms but that never reach the market must be included, if they can be, on the basis of rough estimates or else neglected entirely. Significant parts of total output – land clearing and drainage, timber felling and sawing, barn raising, food preparation and canning, the care of children, the sick and the aged, the repair of equipment and furniture, the provision of knowledge and entertainment – have moved from the household to the market and sometimes back again and so biased measures of growth either upward or downward. There are analogous troubles with our measures of the sources of ourput growth. In particular, the contributions of the various sources, which appear in the tables as if they acted on growth independently of one another, are, in fact, to some unknown but significant degree the result of the joint action of two or more sources. Perhaps most important of all, the great advances in the quality and variety of goods and services register quite inadequately in our measures of output. Whether bacterial pneumonia is treated with poultices or penicillin makes no difference to our measures of output so long as their unit cost in the base years of the GDP indexes is the same. And so with communication by pony express, by telegraph, telephone or E-mail. A quality adjusted measure of output would on this account rise faster than the existing mea-

[2] Several chapters in Volume II of *The Cambridge Economic History of the United States* deal with the same subjects. See in particular the chapters by Robert E. Gallman, "Economic Growth and Structural Change in the Long Nineteenth Century" and by Robert A. Margo, "The Labor Force in the Nineteenth Century."

sures. But existing measures also neglect the disamenities and costs of growth, for example the congestion, pollution, noise, and crime of cities – to be balanced, of course, against their cultural wealth, intellectual vigor, and stimulation. No one can say exactly how a truly comprehensive measure of growth would look and there is no utterly objective way to provide one. These real difficulties must be set aside, but not lost to mind. We return to them later. Meanwhile we study the growth of output per capita because it is the only measure of the aggregate of goods and services available to people on the average over long periods of time.

The growth we study in this chapter refers to the long-term or sustained increase in national product. This means the growth that persists, not only across the inevitable year-to-year ups and downs of business activity, but also across the more extended fluctuations that reverse themselves only over a period of years. In the American economy of the nineteenth and early twentieth centuries, these fluctuations took two forms. One was the familiar "business cycle," which until the 1960s typically had a duration in this country of about five years. When, however, the effects of such business cycles are attenuated by calculating growth rates between the average levels or peak years of successive cycles, a second wave of longer duration emerges. In the American experience, these "long swings" succeeded one another at intervals of fifteen to twenty-five years from early in the nineteenth century until about 1930 and, with some differences in mechanism, thereafter as well. To measure the trends of sustained growth properly, therefore, we must calculate growth rates between similar phases of long swings and choose years to represent those phases that are comparable in their business-cycle position.

There was a remaining element of irregularity. It was especially important during the long-swing intervals of 1855 to 1871 and 1929 to 1948. The first spans the Civil War and its disturbed aftermath. The second spans the Great Depression of the 1930s and the intense but war-directed activity of World War II. Both were marked by large and anomalous slowdowns in output growth. The Depression of the thirties, which discouraged investment, and the war, which imposed restrictions on civilian investment, caused a serious reduction in private capital accumulation and retarded normal productivity growth. The effect of the Civil War was even more pronounced. The extraordinary upsurges of output, capital accumulation, and productivity growth in the periods that followed these wars and depressions were, in part, rebounds based on exploiting backlogs of postponed investment and technological innovation and, in the case of the

Table 1.1. *The output growth rates of the national economy and the U.S. private domestic economy, 1800–1989 (average compound rates over "Long Periods," in percent per annum)*

				Per capita rates		Intensive growth fraction (percentages)	
Periods	GNP	GPDP	Population	(GNP/P)	(GPDP/P)	GNP	GPDP
I. The Nineteenth Century							
1800–55	3.99	3.93	3.03	0.93	0.87	23	22
1855–90	4.00	3.92	2.41	1.55	1.47	39	38
1890–1927	3.56	3.50	1.73	1.80	1.74	51	50
II. The Twentieth Century							
1890–1927	3.76	3.70	1.73	2.00	1.94	53	52
1929–66	3.18	3.05	1.30	1.86	1.73	58	57
1966–89	2.69	2.86	1.00	1.67	1.84	62	64

Note: Here and in Tables 1.2–1.4, the dates 1855, 1890 and 1927 are the midpoints of five-year averages ending with the peak year of a "long swing". Thus the period 1855–90 is more properly 1853–57 to 1888–92. Other terminal years are single years chosen to represent the peaks of long swings.
Sources: See Statistical Appendix.

Civil War, gradually overcoming the great wartime and post-war disruption of the economy of the South. Combining the records of the disturbed periods with the rebounds that followed offers a better view of the underlying long-term trends of economic advance. Table 1.1 and similar tables in the text are designed to do that.

Finally, the figures throughout are afflicted by errors of estimation, but we judge that these are more serious before the Civil War than after. To get a more accurate picture of long-term growth, it seems better, therefore, to view the pre-Civil War development as a whole. The result is the long period 1800–55, which appears in Table 1.1 and in later tables. We call the figures in Table 1.1 and in analogous later tables "Measures Across Long Periods."

The scope of output on which the chapter focuses attention is the "private domestic economy." This is somewhat smaller than the national product as a whole in that the former excludes "government product," which is the payments made by governments directly to the factors of production. Essentially that means the compensation of government employees, because the national accounts treat government interest payments, not

as factor compensation, but as transfers. In order to produce a total product made by factors working within the country, the private domestic economy also excludes net factor incomes from abroad, that is, the excess of incomes earned by the labor and capital of U.S. nationals employed abroad over the incomes earned by foreign nationals and foreign capital situated in the United States. Neither item was of significant size in the nineteenth century. And while government product has become of much greater importance since, the long-term rates of growth of aggregate national product and private domestic product have remained quite similar.

Private domestic product, nevertheless, is a better basis for productivity measurement than is the aggregate national product. That is because the real, inflation-corrected, product of government is obtained by deflating current dollar wage payments by an index of nominal wages per worker. Real government product, therefore, emerges essentially as a measure of the growth of government employment. The productivity change, presumably the increase in productivity, of government workers, disappears, which introduces a downward bias into measures of the productivity of national rather than private scope.

The first section in each table deals with the nineteenth century, the second section with the twentieth. The sources and, to some degree, the methods of estimate of the output figures are somewhat different in the two frames. The tables, therefore, show figures for overlapping periods around the turn of the century on both bases. The figures in the first section for the turn of the century are better for comparisons with earlier years; the figures in the second section for the same period are better for comparisons with later years.

The output figures in Table 1.1 and in most later tables represent gross product before allowance for depreciation. Net product after depreciation would, indeed, be a better measure of output relevant to economic welfare. The long-term growth rates of net and gross output, however, are not significantly different, and gross output is a better basis for the measurement of productivity.

Output, Population, and Output per Capita

Table 1.1 and Tables 1.2 to 1.4 that follow encapsulate the main features of nearly two centuries of American development as it appears in the pace of measured output growth and its proximate sources. These numbers can be only the beginning of a search for the forces governing growth, but

they are a useful beginning, a framework that suggests the quantitative outlines of the American experience.

When we look at the record across the long periods of Table 1.1, it appears that the 1800s were a century of 4 percent growth of aggregate product. And this was true whether we look at growth in the national economy (GNP) or in the private domestic economy (GPDP). Beginning around the turn of the century, however, the pace began to fall off. From the 4 percent growth of the last century, it has gradually declined until in the most recent quarter-century it was under 3 percent a year. Both the 4 percent rate of the 1800s and the gradual slowdown in the 1900s, however, were the outcome of divergent movements in the components of aggregate output growth, that is, population growth and per capita output growth.

Population growth in the first half of the last century was very rapid. With few reversals it has slowed down ever since. The transient baby boom years of the 1950s and early 1960s were a notable exception. Per capita output growth, however, speeded up. It did so in two steps, a large one between the first and second halves of the last century, a smaller but still substantial one between the second half of the nineteenth century and the first quarter of the twentieth. The rate of about 1.8 or 1.9 percent a year that was achieved in private domestic product per capita between 1890 and 1927 was then roughly maintained, when viewed over suitably long periods, for the rest of the century. It was, indeed, a remarkably rapid pace. Sustained so long, it was enough to make the measured level of private output per head nearly six times as high in 1990 as it had been a century earlier.

With population growth declining, the big step-up of per capita growth during the last century was enough to sustain the pace of growth of the aggregate in the 1800s. With population growth declining still faster in the 1900s, the smaller step-up in per capita growth across the turn of the century, *a fortiori* its stability since that time, was not. So aggregate output growth measured over long periods, has declined steadily since the beginning of the present century.

This is the big picture. Within the long periods of Table 1.1, however, economic growth suffered fluctuations that deserve notice. The more important of these emerge in the measures across long-swing intervals. For example, the private per capita growth rate in the cross-Civil War interval (1855–71) fell to a pace approaching zero, while in the 1870s and

1880s, during the rebound from the war, the growth rate was higher than in any similar interval before or since. There then followed a slowdown, the seriousness of which is perhaps muted by the timing of long-swing intervals. The impact of the Great Depression and World War II, taken together, however, emerges clearly; and so does the rebound that followed.

If we look beyond the simple arithmetic of Table 1.1, it is clear that output per capita and population growth interact. The outcome has turned on a balance of offsetting influences. On the one side, powerful influences connected with the rise of per capita product and productivity and, more especially with the technological progress behind it, made for a decline in mortality. The migration to the cities, however, where death rates were relatively high, at first tended to raise mortality. Beginning around 1870, a movement to improve sanitation, together with a gradual betterment of nutrition, served to curb disease and morbidity generally. Still more important, the advance of knowledge that supports productivity growth included the germ theory of disease. It persuaded people to accept the expensive projects needed to bring clean water to the growing cities and to remove their wastes. Building on the anti-bacterial work of Robert Koch and Louis Pasteur in the 1870s and 1880s, growing knowledge also led to the greet reductions of small pox, diphtheria, scarlet fever, and measles made possible by vaccination and the inoculation of anti-toxins. Later in the twentieth century came the dramatic improvements in the cure of infections with antibiotics. Increasing knowledge also brought valuable ways of detecting and treating cancers and avoiding and curing cardiac disease.[3]

High and rising levels of income and, mainly in the nineteenth century, cheap land attracted immigrants. And a large flow of immigrants did, indeed, account for a considerable part of the total increase of population from early in the nineteenth century to World War I. From the 1840s until World War I, approximately a quarter of the growth rate of total population was attributable directly to immigration. The children of immigrants added still more. Between the early 1920s and about 1970, the flow of immigrants, restricted by federal legislation, was much less important. It made up only some 11 percent of the rate of population growth. In the last 25 years, however, migration, legal and illegal, has again risen in importance.

[3] See Richard Easterlin, chap. 9 in this volume. See also Easterlin, "Industrial Revolution and Mortality Revolution: Two of a Kind?" *Evolutionary Economics*, 5 (1995), 393–408, and Michael R. Haines, chap. 4 in vol. II of this series.

It is the birth rate, however, that has been most weighty in governing changes in the growth of population. It is true that rising levels of income, taken by themselves, make it easier for young people to marry early and to raise large families. Other circumstances accompanying income growth itself have, nevertheless, worked in the opposite direction and produced the long-term trend toward lower birth rates and a decline in the rate of population growth. In the nineteenth century, the intensification of settlement gradually raised the price of land and made it difficult to establish numerous children on nearby farms. Industrialization attracted people to the cities where the costs of space were higher and where children were less well able to contribute to family income. It also weakened the economic bonds between generations that family farms and other family businesses create. So it reduced the economic security that children offered to parents and in that way undercut the attractions of a large family. It enlarged the opportunities of women for paid work outside the home and so raised the costs of devoting effort and attention to family. Remunerative and attractive employment in this century came to depend increasingly on higher levels and longer years of education, which again raised the costs of bringing children to adulthood. The technical progress on which, as we shall see, per capita output growth largely rests, included progress in the means of contraception. And the spread of education helped to diffuse knowledge of contraceptive techniques and made people more ready to use them. In sum – the decline in population growth and thus in aggregate output growth stemmed in large part from the rising level of per capita output, or, better, from the forces that support it and the conditions of life that go with it.[4]

There are also reverse influences that run from population growth to the rise of per capita output. An increase in population, if it presses on scarce resources, tends to reduce output per capita. In the conditions of land and resource abundance characteristic of the United States, however, the chief effect of population growth has been to raise the level of aggregate output by its effect, subject to a lag, on the growth of the labor supply. By its effect on the size of the domestic market it opened the way to a larger exploitation of the economies of large-scale production and so to higher output per capita as well. In these circumstances, the declining rate of population growth in the present century would have acted to limit the poten-

[4] Easterlin, chap. 9 in this volume, and his "The American Population" in Lance E. Davis, Richard A. Easterlin, William N. Parker, et al., *American Economic Growth: An Economist's History of the United States* (New York, 1972), chap. 5.

tial contribution of the economies of scale to the growth of productivity and per capita income. The twentieth century's declining population growth rates may, therefore, have been a constraint on aggregate output growth, not only because they tended to reduce the growth rate of the labor force but also because they held back the growth of labor productivity. But labor productivity rose for other reasons, and these must still be explored. We turn first, however, to review the course of labor input.

The Changing Contribution of Labor Input per Capita

Per capita output growth may be viewed as the sum of the growth rates of the annual number of hours of work per year per head of the population and of output per hour.

During the nineteenth century, per capita labor input rose at a rate somewhat under one-half percent a year (Table 1.2). This seemingly modest pace, however, amounted to more than 50 percent of the still low growth rate of per capita output in the first half of that century. But even in the second half, when per capita output growth had risen toward rates more familiar now, about a quarter of the advance was still derived from the growth of labor input per head.

In the twentieth century, by contrast, things were quite different. The input of labor hours began to decline on a per capita basis and did so at an accelerating pace. Given the high and steady rate of per capita output growth, this implies that long-term labor productivity growth was accelerating, at least through the first three quarters of the century (1890–1966). And then there was a reversal. During the quarter-century since 1966, the growth of per capita labor input jumped again to the higher rates characteristic of the nineteenth century, while labor productivity growth fell back to a slow pace not seen since the turn of the century, perhaps earlier. The two developments were, to some degree, connected.

The growth of labor hours per capita can itself be decomposed, and this is done in Table 1.3. Here the growth of labor hours per head is viewed as the sum of the growth rates of the labor force per head of the population, of full-time equivalent persons at work ("persons engaged") per member of the labor force, and of hours of work per person engaged. The sum of the latter two rates is the growth rate of hours per member of the labor force.

Table 1.2. *Contributions of labor input and labor productivity growth rates to the growth rate of output per capita: U.S. private domestic economy, 1800–1989 (average compound rates over "Long Periods," in percent per annum)*

Periods	Output per capita	Manhours per capita	Output per manhour
I. The Nineteenth Century			
1800–1855	0.87	0.48	0.39
1855–1890	1.47	0.41	1.06
1890–1927	1.74	−0.26	2.01
II. The Twentieth Century			
1890–1927	1.94	−0.07	2.00
1929–1966	1.73	−0.78	2.52
1966–1989	1.84	0.60	1.23

Sources: See Statistical Appendix.

Table 1.3. *Decomposition of the growth rate of manhours per capita: U.S. private domestic economy, 1800–1989 (average compound rates over "Long Periods," in percent per annum)*

Periods	Manhours per capita	Labor Force per capita	Persons engaged per member of the labor force	Manhours per person engaged
I. The Nineteenth Century				
1800–1855	0.48	0.19	0.14	0.15
1855–1890	0.41	0.33	0.07	0.02
1890–1927	−0.26	0.16	−0.17	−0.26
II. The Twentieth Century				
1890–1927	−0.07	0.16	0.01	−0.24
1929–1966	−0.78	−0.09	−0.24	−0.44
1966–1989	0.60	1.12	−0.11	−0.37

Sources: See Statistical Appendix.

The strong growth of per capita labor input during the nineteenth century was due in part to the first of these components, that is to the faster growth of the labor force than of population. This is traceable partly to the effect of immigration, which brought in more people of working age than it did children, women, and old dependents, and partly to the manner in which population growth declined. Because birth rates fell faster than death rates, the proportion of dependent children and youth declined relative to adult groups, and the population of working age rose compared with the general population.

The growth of labor input, especially in the first half of the nineteenth century, was bolstered as well by increases in the ratios of employment to labor force and of hours per person employed. Both developments were connected with the shift of population and employment from farming and rural life to the towns and cities and to employment in the growing non-farm sectors. Urban life gave women a better chance for paid (and, therefore, recorded) employment outside the home. And full-time annual hours of work on the farms, because of its seasonal nature, were only some 75 percent as much as annual hours in the non-farm sector.[5]

As one moves into the twentieth century, the balance of forces changed, producing first a slow, then a very rapid decline in labor input per head, which continued into the 1960s. Both long-term and transitory factors were at work. In the first third of the century, from about 1890 through 1929, the same balance of demographic developments, the relative growth of the population of working age, reflecting the decline of birth rates and, therefore, of dependent children, and until World War I, the continued flow of immigrants in large numbers produced a continuing rise in the importance of the working-age population and in the ratio of labor force to population. This was more than offset, however, by a more rapid drop in non-farm hours of work. The hours decline took place especially rapidly during World War I when workers took advantage of tight labor markets to gain shorter hours without a drop in pay. By 1919, this drop in average non-farm hours, together with a smaller rise in average annual farm hours, had made annual hours per worker in the two sectors about equal. The farm-non-farm shift no longer worked to support the growth of labor input.

Apart from these long-term developments, an important feature of the years since 1929 was a large and protracted fluctuation in labor input per

[5] John W. Kendrick, *Productivity Trends in the United States* (Princeton, 1961), Table A-IX, and Paul A. David, "Real Income and Economic Welfare Growth in the Early Republic" (1996).

capita. The decline, which had begun in the early part of the century, accelerated between 1929 and 1966 and proceeded at a multiple of its earlier pace.[6] And then it turned around; for the last quarter century, it has been rising almost as fast as it fell during the preceding four decades. Without the decline of labor input per capita in the middle decades of the century, the rate of advance of per capita output during the post-war growth boom would have been still more rapid; without the rise in the 1970s and 1980s the severe slowdown of labor productivity growth would have produced a marked decline in output per capita as well.

The sources of the large fluctuation in the growth of labor input per capita in the twentieth century are complex. Some of the considerations are suggested in Table 1.4. Here we view the growth of labor-force per (the labor-force ratio) as the sum of the growth rates of the working-age ratio – that is, the ratio between the working-age and the total population – and the gross participation rate, that is, the ratio between the number of persons in the labor force and the working-age population. We call it the *gross* rate because it reflects changes both in the participation rates of specific groups, distinguished by age, sex and other characteristics, and in the importance of the groups.

In the first period, from 1929 to 1948, the growth of the working-age ratio was modest. This was a direct consequence of the birth rate reversal, from the low and declining rates that prevailed during the late twenties and the decade of the Great Depression, to the higher fertility levels that accompanied the tightening of labor markets during the forties. The depressed birth rate cut the fraction of children in the population and so pushed up the working-age ratio, whereas after 1945 the beginnings of the baby boom reversed the process.

The two decades following World War II saw no reversals of comparable magnitude in the fertility of Americans: the birth rate and the general fertility rate climbed rapidly to a peak at the end of the 1950s, and held at high levels for some years thereafter. Consequently, the proportion of the population made up of young dependents rose rapidly and the working-age ratio dropped sharply over the period 1948–66, as may be seen from Table 1.4. While this was partially offset by a modest rise in the participation rate, the net effect was that labor force per capita fell rapidly during that interval.

[6] The size of the more severe retardation is uncertain. Comparing 1929–66 with our own estimate for 1890–1927 (shown in Frame I) puts the retardation at 0.5 percent a year. Using Kendrick's estimate for 1890–1927 (Frame II) makes the difference even greater.

Table 1.4. *Components of change in the growth of the labor force participation rate, 1929–89 (average compound growth rates in percent per annum)*

Periods	Labor force per capita	Working-age population ratio	Gross participation rate
1929–1948	0.19	0.17	0.02
1948–1966	−0.38	−0.57	0.19
1966–1989	1.12	0.48	0.64

Sources: Underlying data from: Population: *Economic Report of the President*, Jan. 1993, Table B-29 (Resident population 1929–48; total population including armed forces overseas after 1948.) Working-age population: *Ibid*. Table B-29 (Population, ages 16–64). Labor force: *Ibid*, Table B-30 (Civilian labor force aged 16+.).

Toward the close of the 1960s, however, birth rates started their recent dramatic decline and thus ushered in the latest period when the working age ratio rose almost as rapidly as it had dropped in the two decades after World War II. The turnaround, which raised the growth rate of the working-age ratio by a full percentage point (from −0.57 to +0.48 percent a year) accounted for 70 percent of the marked increase in the growth of labor force per capita.

The large fluctuation in birth rates and the accompanying decline and then increase in the growth rates of the working-age and labor-force ratio have been well explained by Richard Easterlin.[7] On his hypothesis, fluctuations in birth rates are caused by changes in the economic circumstances and prospects of young adults in their most fertile years, taken in conjunction with the expectations they had earlier formed in their parents' households. Given the twenty-year or so lag between birth and entry into labor force and marriage, a kind of cycle is generated. Thus the cohort who came of age during the Great Depression, and who carried with them expectations formed in the prosperous 1920s, married late and had few children. By contrast, the young adults of the 1950s and early 1960s were a much smaller cohort, reflecting the low birth rates of the 1930s and early 1940s. This small supply of young workers, meeting the buoyant labor market of the post-war years, found good jobs and enjoyed early promotion and rising wages. And given the modest expectation they had formed in the depressed 1930s, they married early and generated the baby boom.

[7] See Easterlin's chapter in this volume, and Richard Easterlin, *Population, Labor Force, and Long Swings in Economic Growth: The American Experience* (New York, 1968).

They then spawned the large cohort of young people whose expectations were consistent with the happy state of their parents' households. And these then entered the labor force in the 1970s and 1980s where they met the recent slowdown of productivity growth, the accompanying stagnation of real wages, and slower promotion. A rapid decline of birth rates followed.

A competing hypothesis lays greater stress on the long-term trend towards lower birth rates to explain the low rates of recent decades. It sees the baby boom as an aberration and the more recent decline in the birth rate as primarily a response to the forces controlling the long-term trend. There is, in fact, much to be said about the sources of the long-term trends that have helped bring birth rates to their present low levels. The economic and social conditions of that century have, indeed, made children more expensive to raise and perhaps reduced the benefits that parents may derive from them. Children can no longer contribute to the ordinary family's work and income as they did on the farms of a century ago. They occupy more costly house room in the city. They require long years of increasingly expensive medical care and education. They compete for the time, effort, and income of their mothers when the world of paid employment has been opened to women. As adults they live separated from their parents by independent employment and often by long distances; they cannot offer the support and care for the elderly that they once did. And the parental support they used to provide is now far less important when the elderly can depend on Social Security and private pensions, on Medicare and on retirement communities. Young adults, therefore, are less likely to see the benefits and virtues of large families.

Still, there are birth rate effects that stem from disjunctures between labor demand and supply. When they occur, they have effects that echo a generation later. Moreover, they may echo once again, perhaps with diminished force, until a new disjuncture of independent origin occurs and starts the process once more. The Easterlin echo effects have been an important component of the growth of labor input in the twentieth century and earlier, and we may see them again.

Labor Productivity Growth and Its Sources

Between the first half of the nineteenth century and the second half (counting the years from about 1855 to about 1890 as the "second half"), the pace of labor productivity growth more than doubled. Then between the second

half of that century and the first third of the twentieth century (1890–1927), it doubled again (Table 1.5). And between the first and second thirds of the twentieth century, it increased still again, by 26 percent. Counting, therefore, from the slow rate of the first part of the nineteenth century to the far more rapid pace of the middle decades of the twentieth, there were more than a hundred years of accelerating long-term labor-productivity growth. True, this record of unbroken acceleration emerges when growth is measured over the long periods identified in Table 1.5. Within these long periods, across the "long swing intervals" they span, there was a succession of slowdowns and accelerations. And if we broke the record into still shorter intervals, the fluctuations of the labor productivity growth rate would be still more marked. Wars, depressions, post-war rebounds and booms, the vagaries of the pace of technological progress have all counted. Still, the record of long-term acceleration is clear enough.

Against this accelerating trend of labor productivity growth rates, the quarter-century from 1966 to the end of the twentieth century is something of an anomaly. The occurrence of a slowdown is not in itself strange. As said, there have been many precedents. It is the severity of the current retardation and its duration which give this latest episode its special character. Compared with the preceding long period between 1929 and 1966, the rate of advance fell 51 percent. Compared with the booming growth of the post-war years (1948–66), the rate declined no less than 60 percent. Not since the second half of the nineteenth century, if we depend on the long-period measures, has the pace of labor productivity growth been so slow.

It is sometimes argued that the slowdown in the years since the late 1960s, is not in itself evidence of long-term retardation. In this view, the slowdown may be only a transitory matter, comparable with the declines in productivity growth that accompanied serious depressions in the past.[8] The slowdown that began after 1966, however, had by the close of the 1980s, gone on for almost a quarter-century, which is longer than the full long swings of the past, their contractions plus their expansions. Signs of a faster long-term growth rate in the years since 1989 are still uncertain. The decline of the labor productivity growth rate between the previous long swing (1948–66) and the period of slowdown (1966–89) is 1.9 percentage points. Earlier in the twentieth century, the most drastic slowdown was that between the prosperous twenties and the depressed

[8] This is the contention of William J. Baumol, Sue Ann Batey Blackman, and Edward N. Wolff, *Productivity and American Leadership: The Long View* (Cambridge, MA, 1989), chap. 4.

Table 1.5. *The sources of labor productivity growth, U.S. private domestic economy, 1800–1989 (sources in percentag*
across long periods)

	I. Nineteenth Century			II. Twentieth Ce	
	1800–1855	1855–1890	1890–1927	1890–1927	1929–1966
1. Output per manhour	0.39	1.06	2.01	2.00	2.52
Sources					
2. Capital stock per manhour	0.19	0.69	0.62	0.51	0.43
3. Crude total factor productivity	0.20	0.37	1.39	1.49	2.09
4. Labor quality	—	—	0.15	0.15	0.40 (0.30)
5. Capital quality	—	—	—	—	0.24
6. Refined total factor productivity	0.20	0.37	1.24	1.34	1.45 (1.55)
Addenda					
7. Gross factor share weights					
a. Labor	0.65	0.55	0.54	0.58	0.64
b. Capital	0.35	0.45	0.46	0.42	0.36
8. Vintage effect	—			—	0.04 (0.05)
9. Age-neutral refined total factor productivity	—			—	1.41 (1.50)

Sources: See text discussion and Statistical Appendix.