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PRODUCTIVITY TRENDS BY SECTOR AND MAJOR INDUSTRY GROUP

This chapter compares sector trends in output, input, and productivity over the period 1929–65, the earliest and latest years for which comparable data are available. Annual rates of change are also calculated for subperiods 1929–47 and 1947–65, and the latter period is further subdivided into 1947–56 and 1956–65. The rates of change for the shorter periods are generally less reliable than for the longer ones as measures of trend, because cyclical and irregular factors as well as measurement errors in the initial and terminal years increase in importance as the span shortens.

In addition to the sector comparisons, rates of change for each major industry group are shown relative to the national rate and correlations are calculated across industry groups for various measures of output, input, and productivity. The productivity measures include output per man, output per unit of labor input, and output per unit of total factor input. Comparison of these measures suggests important sector differences in the growth of the quality of labor and of capital per worker. These differences are explored, and are used to help explain the relative growth of service employment.

Measures of Input and Output

The data used in this chapter are drawn primarily from material provided by the U.S. Office of Business Economics and from previous studies of the National Bureau of Economic Research. A discussion of the principal concepts and sources follows.

Output

Output is measured by estimates of gross product originating in each industry in 1958 dollars.[1] This is conceptually similar to the gross na-

[1] Gross product by industry for 1947–65 was taken from U.S. Department of

tional product, but the method of obtaining constant-dollar estimates differs from the total and from industry to industry. In principle, the effect of price change is eliminated by the method known as "double deflation"; that is, the output of an industry and its purchases are each deflated separately and the difference between the two deflated figures is taken as the gross product in constant dollars. With modifications, this method was used by the Commerce Department for farms, construction, manufacturing, the major portions of finance and insurance, electrical and gas utilities, and railroads. In other industries, real product was estimated by extrapolating the base-year product by an index of the quantity of total output. The estimates for the period 1929–47 are based on Kendrick's indexes of real output.[2]

Gross product in constant dollars is not a completely satisfactory measure of real output by industry, but it is probably the best available for industry productivity analysis. One advantage is that the industry totals (with the exception of a very small "statistical discrepancy") do equal the total GNP, and it is therefore possible to calculate industry productivity measures relative to the total economy. Probably the most important defect of the gross product measures is that output in some industries is estimated from employment data. This problem is most serious in government and some of the other industries in the Service sector. The possible effect of biases in the output measures on trends in productivity is discussed later in this chapter and in Chapter 5.

It should be noted that much of the analysis presented here is concerned with differential changes in various inputs and will be equally relevant if some different, and presumably superior, output measures become available.

Employment

The Department of Commerce series "Number of Persons Engaged in Production" is used to measure changes in employment. This series includes self-employed as well as employees reduced to full-time equivalents, and is probably reasonably accurate. The exclusion of unpaid

Commerce Office of Business Economics, "Revised Estimates of GNP by Major Industries," *Survey of Current Business,* April 1967. Data for 1929 were estimated from rates of change published in Martin L. Marimont, "GNP by Major Industries," *Survey of Current Business,* October 1962.

[2] John W. Kendrick, *Productivity Trends in the United States,* Princeton University Press for National Bureau of Economic Research, 1961. It may be noted that for the years after 1947, where comparison between Kendrick's output indexes and the Office of Business Economics estimates of real gross product is possible, the two methods yield almost identical results for the sector aggregates.

family workers may introduce some measurement errors in agriculture and trade, while the method of converting part-time employment into full-time equivalents may introduce some bias in industries, such as services, where part-time employment is significant.[3]

Total Labor Input

Employment data may not provide a completely satisfactory measure of total labor input for several reasons. First, there are possible defects in the employment series, as illustrated by the problem of converting part-time employment to full-time equivalents. Second, there is the problem of obtaining accurate information concerning the average number of hours actually worked each year by full-time employees. In a preliminary report on this problem,[4] estimates were made for changes in man-hours. However, recent investigations of changes in weekly hours for manufacturing and retailing have cast considerable doubt on the previously accepted estimates of changes in hours between 1929 and 1947.[5] Because of the uncertainty it was decided not to present measures of output per man-hour. Since 1947, there have been only small changes in weekly hours for full-time employees; therefore, measures of output per man-hour are substantially the same as output per full-time equivalent employed persons.

A third difficulty is in interpreting changes in man-hours even if accurate data were available. Decreases in weekly hours, when hours are long, may be offset in part by an increase in effective labor input per hour because of lessened fatigue.[6] Finally, man-hours data tell us nothing about the quality of labor attributable to differences in intelligence, strength, training, and so on. It would be useful to have a measure of labor input which took account of all these factors.

[3] In converting part-time employment into full-time equivalents, the Office of Business Economics divides the payroll of part-time employees by the average earnings of full-time employees. If, as seems likely, part-time employees earn less per hour than full-time employees, the OBE procedure will understate the true full-time equivalent employment and will overstate the average annual earnings obtained by dividing total payroll by full-time equivalent employment so estimated.

[4] Victor R. Fuchs, *Productivity Trends in the Goods and Service Sectors, 1929–61: A Preliminary Survey,* NBER, Occasional Paper 89, New York, 1964.

[5] Ethel B. Jones, "New Estimates of Hours of Work Per Week and Hourly Earnings, 1900–1957," *Review of Economics and Statistics,* November 1963; David Schwartzman, "Analysis of Productivity Change in Retail Trade 1929–63," NBER manuscript.

[6] See discussion of this point by Edward F. Denison, in *The Sources of Economic Growth in the United States and the Alternatives Before Us,* Committee for Economic Development, Supplementary Paper No. 13, New York, January 1962, p. 40. See also Irving F. Leveson, "Reductions in Hours of Work as a Source of Productivity Growth," *The Journal of Political Economy,* April 1967.

Provided we accept certain assumptions, we may be able to approach such a measure through the data on labor compensation. Total labor compensation includes wages and salaries, supplements to wages and salaries, and the labor income of the self-employed. If we assume that the price of labor (adjusted for quality, effort, etc.) changes at the same rate in all branches of the economy, then the change in total labor compensation in a particular industry relative to the change in the economy as a whole is equal to the change in labor input in that industry relative to the change in labor input for the economy as a whole.[7]

Note that this formulation does not require that a dollar's worth of compensation buy the same amount of labor input in all industries in either the initial or the terminal year. There may be variations based on nonpecuniary factors, monopoly or monopsony power, and so on. The relative change in compensation will still be equal to the relative change in labor input, provided these other factors do not change from industry to industry over time.

The estimates of total labor compensation by industry are based on the Office of Business Economics estimates of the compensation of employees (full-time equivalents) [8] plus estimates of the returns to labor for proprietors of unincorporated businesses. Proprietors' income is defined as the sum of income of unincorporated enterprises plus the inventory valuation adjustment of unincorporated enterprises. Labor's share of proprietors' income was assumed to be 60 per cent in agriculture, 80 per cent in finance, insurance, and real estate, 90 per cent in mining, manufacturing, transportation, communications, and public utilities, and wholesale and retail trades, and 95 per cent in construction and services. These percentages are based on information about the relative amounts of net worth in each industry.[9]

Total Factor Input

The foregoing suggests that relative changes in labor compensation may be used to estimate relative changes in labor input. Similarly, relative changes in total compensation (measured approximately by gross

[7] See equation 1, Appendix B. Possible biases in this measure are discussed later in this chaper in the section on the quality of labor.

[8] The Office of Business Economics data on compensation per man by industry were compared with industry wage and salary data collected by the Bureau of the Census in its *Current Population Survey* for 1948 through 1960, as reported in Herman P. Miller, *Trends in the Income of Families and Persons in the United States: 1947–1960,* Bureau of the Census Technical Paper No. 8, Washington, D.C., 1963, Table 17. The sector differentials were almost identical.

[9] See Irving Leveson, "Nonfarm Self-Employment in the United States," unpublished Ph.D. dissertation, Columbia University, 1967, Chapter 4.

product in current dollars) may be used to estimate relative changes in total factor input. In this case we assume that the price of a unit of composite factor inputs (land, labor, and capital) has changed at the same rate in all branches of the economy.[10] This assumption is less likely to be true than the same assumption for a single factor because relative factor prices have changed and industry factor proportions differ. Some independent verification is possible through direct estimation of capital input, to be discussed later.

Trends in Productivity

We are now ready to turn to productivity measures themselves. All changes are expressed as annual rates (continuously compounded) between the initial and terminal years. Productivity is always shown as a residual—the difference between the rate of change of real output and the rate of change of whatever input or combination of inputs we are concerned with at the moment.

Two of the variants of productivity—output per unit of labor input and output per unit of total factor input—are only shown in relative terms because of the great difficulties encountered in measuring the absolute change in these variables.[11] Many of the sources of errors affect most industries. It is possible, therefore, to have greater confidence in the sector differentials in the rates of change of these measures than in the absolute rates of change for any one sector or for the total economy.

Sector Comparisons of Productivity Change

Sector rates of change of output, employment, and output per man are presented in Table 15.[12] We see that gains in output per man have been much more rapid since 1947 than before, and that this is true for all sectors. In fact, the rate of growth of productivity in the Service sector, 1947–65, exceeded that of the Industry sector, 1929–47. Employment has grown at about the same rate over the entire span, except

[10] See equation 2, Appendix B. For a discussion of this method, see Denison, *Sources of Economic Growth,* pp. 218, 219.

[11] Edward F. Denison's study, *Sources of Economic Growth,* is one of the most ambitious attempts at such measurement for the total economy. According to Denison, total labor input (adjusted for hours, quality, etc.) grew at a rate of 2.2 per cent per annum between 1929 and 1957, and total factor input grew at a rate of 2.1 per cent per annum. There is some reason to believe that these rates are biased upward because the contribution of increased education to input was inferred from cross-sectional differences in *annual income* rather than from the smaller and more relevant cross-sectional differences in *hourly earnings.*

[12] The rates for the major industry groups will be discussed later in this chapter.

TABLE 15

Rates of Change of Output, Employment, and Output Per Man, by Sector and Major Industry Group, 1929–65 and Selected Subperiods
(per cent per annum)

	1929–65			1929–47			1947–65			1947–56			1956–65		
	Output	Employment	Output Per Man [a]	Output	Employment	Output Per Man [a]	Output	Employment	Output Per Man [a]	Output	Employment	Output Per Man [a]	Output	Employment	Output Per Man [a]
Total economy	3.1	1.2	1.9	2.5	1.2	1.3	3.7	1.2	2.6	3.9	1.4	2.6	3.5	1.0	2.6
Agriculture	1.1	−2.3	3.4	0.4	−1.5	1.9	1.9	−3.1	4.9	2.3	−2.8	5.1	1.5	−3.3	4.7
Industry	3.4	1.2	2.2	3.0	1.6	1.5	3.8	0.8	2.9	4.1	1.4	2.8	3.4	0.3	3.1
Service	3.1	2.0	1.1	2.4	1.9	0.5	3.9	2.2	1.7	3.9	2.3	1.6	3.8	2.0	1.8
Service subsector	2.9	1.6	1.2	2.1	1.7	0.4	3.7	1.6	2.1	3.4	1.3	2.1	3.9	1.8	2.1
Industry															
Mining	1.5	−1.2	2.7	1.0	−0.2	1.2	2.1	−2.1	4.1	3.2	−1.1	4.3	0.9	−3.1	4.0
Contract construction	2.2	1.5	0.7	1.2	1.5	−0.3	3.3	1.5	1.7	5.8	2.3	3.5	0.7	0.8	−0.1
Manufacturing	3.7	1.6	2.1	3.3	2.1	1.2	4.0	1.0	3.0	4.2	1.5	2.7	3.8	0.5	3.3
Transportation	2.8	−0.6	3.4	4.2	0.0	4.1	1.5	−1.1	2.7	0.9	−0.9	1.8	2.2	−1.3	3.5
Communications and public utilities	5.6	1.1	4.5	4.0	0.8	3.3	7.1	1.3	5.8	8.2	2.5	5.6	6.0	0.2	5.8
Government enterprise	3.3	2.8	0.5	2.7	2.8	0.0	3.8	2.8	1.1	3.0	3.0	−0.1	4.7	2.6	2.2
Service															
Wholesale and retail trade	3.1	1.5	1.6	2.4	1.8	0.6	3.9	1.2	2.7	3.7	1.2	2.5	4.0	1.1	2.9
Finance, insurance, real estate, and services	2.9	1.7	1.3	1.7	0.9	0.8	4.1	2.4	1.8	4.0	2.1	1.9	4.3	2.7	1.6
Finance, insurance, and services excl. households and institutions	2.5	1.9	0.6	1.7	1.6	0.1	3.3	2.2	1.2	3.0	1.5	1.5	3.7	2.9	0.8
General government	3.8	3.8	0.0	4.4	4.4	0.0	3.2	3.3	−0.1	4.1	4.3	−0.2	2.3	2.3	0.0

Source: See Appendix C.
[a] Output per man calculated from unrounded data.

for a slight acceleration in 1947–56 and a slight deceleration in 1956–65.

Of the three sectors, Agriculture has led in rate of change of output per man in every period. It is noteworthy that the sector that has been declining most rapidly in relative importance, as measured by either output or employment, should have achieved the greatest gains in output per man. Most studies of the relationship between growth and productivity, to be discussed, point to a positive correlation.

Some of the reasons for the rapid growth of output per man in agriculture include government supported research and education programs, substitution of capital (physical and human) for labor, and the movement out of agriculture of marginal producers who were attracted by the strong demand for labor in the nonagricultural sectors. U.S. agriculture, like that of most other countries, apparently harbored, and may still harbor, a considerable amount of "disguised unemployment."

Because many of the conditions in agriculture were fundamentally different from the rest of the economy, and because of the relatively small role of the Agricultural sector currently, the comparison that is emphasized in this book is the differential between the Industry and Service sectors. These differentials, for all measures in all periods, are presented in Table 16, the first portion of which shows each sector's rate of change relative to the national rate. The differential between any two sectors can be obtained by simple subtraction of the relative rates of change.[18]

The Industry-Service comparison reveals a differential of 1.1 per cent per annum in changes in output per man for the 1929–65 period. This differential was approximately the same in all the subperiods. It is this gap of 1.1 per cent that requires explanation. A look at the other measures of productivity provides some clues to portions of the answer.

The differential in output per unit of labor input was only .6 per cent per annum. This means that almost half the differential in output per man may be explained by the discrepancy between the rate of growth of employment and of labor input. The latter, it will be recalled, takes account of differential changes in hours per man and the quality of labor. It is clear from the figures on compensation per man that labor quality has been rising more rapidly in the Industry than in the Service sector. Possible biases in this measure of labor quality will be discussed, but such considerations do not alter this broad conclusion.

The Industry-Service productivity differential is further reduced—

[18] The Industry-Service differentials were calculated from unrounded data and may not, therefore, correspond exactly to those implied by the rounded figures shown in the upper portion of Table 16.

TABLE 16

Sector Rates of Change of Output and Other Variables Relative to the Total Economy, 1929–65 and Selected Subperiods
(per cent per annum)

	1929–65	1929–47	1947–65	1947–56	1956–65
			Agriculture		
Output	−2.1	−2.2	−1.8	−1.6	−2.1
Employment	−3.5	−2.8	−4.2	−4.2	−4.2
Output per man	1.5	0.6	2.4	2.6	2.2
Output per unit of labor input	0.8	−1.9	3.6	7.0	0.0
Output per unit of total factor input	0.5	−2.1	3.1	5.6	0.5
Compensation per man	0.6	2.5	−1.2	−4.4	2.0
			Industry		
Output	0.3	0.5	0.0	0.2	−0.1
Employment	0.0	0.3	−0.3	0.0	−0.7
Output per man	0.3	0.2	0.4	0.2	0.6
Output per unit of labor input	0.3	0.5	0.1	−0.4	0.6
Output per unit of total factor input	0.2	0.2	0.1	−0.4	0.5
Compensation per man	0.0	−0.3	0.3	0.7	−0.1
			Service		
Output	0.0	−0.2	0.1	0.0	0.3
Employment	0.8	0.7	1.0	0.9	1.1
Output per man	−0.9	−0.8	−0.9	−0.9	−0.8
Output per unit of labor input	−0.3	−0.2	−0.5	−0.4	−0.6
Output per unit of total factor input	−0.2	0.1	−0.5	−0.5	−0.6
Compensation per man	−0.5	−0.7	−0.4	−0.6	−0.2
			Service Subsector		
Output	−0.2	−0.4	−0.1	−0.5	0.4
Employment	0.4	0.5	0.4	−0.1	0.8
Output per man	−0.7	−0.9	−0.5	−0.4	−0.5
Output per unit of labor input	0.0	−0.1	0.0	0.1	0.0
Output per unit of total factor input	−0.3	−0.7	0.0	0.1	0.0
Compensation per man	−0.7	−0.8	−0.5	−0.5	−0.4
			Industry Minus Service		
Output	0.3	0.7	−0.1	0.2	−0.4
Employment	−0.9	−0.4	−1.3	−1.0	−1.7
Output per man	1.1	1.0	1.2	1.2	1.4
Output per unit of labor input	0.6	0.7	0.6	−0.1	1.2
Output per unit of total factor input	0.4	0.2	0.6	0.1	1.1
Compensation per man	0.5	0.3	0.7	1.2	0.1

Source: See notes to Table 15.

to .4 per cent per annum—when we look at output per unit of total factor input. This measure is based on the reciprocal of the rates of change of prices in the two sectors. That is, the implicit price deflator for the Service sector rose .4 per cent per annum faster than did the implicit price deflator for the Industry sector. This definition of productivity comes closest to what is often inferred from the term, namely, efficiency in the use of resources. It also comes closest to measuring the rate of technological advance. To the extent that output per man has been rising more rapidly in Industry than in the Service sector because the quality of labor or capital per man has been rising more rapidly, there is no basis for inferring that efficiency or technology have been lagging in the Service sector. To be sure, this method of measuring total factor productivity may be biased, and some of the possible biases will be discussed later in this chapter.

The sector differentials in output per man are remarkably similar in each of the subperiods. The other productivity measures show greater variability, but much of this may be spurious. It is probably the result of the method of measuring changes in labor input and total factor input, which is much less reliable for short than for long periods. In particular, 1947 was almost certainly not a year characterized by the long-run equilibrium conditions that this method requires.

Productivity by Major Industry Group

The discussion thus far has been entirely in terms of sector totals. It is important also to look at productivity change in the individual industry groups that make up the two sectors. At the end of his study of employment in the service industries, Stigler reached the conclusion that "No simple rule describes the trend of employment in the promiscuous ensemble of service industries. . . . Responsible predictions of trends in this large area will not be possible until we have pushed much further in the study of individual industries." [14]

Table 17 shows the relation of the change in output, employment, and output per man (shown in absolute terms in Table 15) to the total economy for 1929–65. The range of productivity gains across industries is very large, with communications and public utilities typically leading and general government typically showing the slowest growth. There is considerable variation within each sector as well as between sectors, but for output per man the between-sector variance is considerably larger than

[14] George J. Stigler, *Trends in Employment in the Service Industries,* Princeton University Press for National Bureau of Economic Research, 1956, p. 166.

TABLE 17

Rates of Change of Output, Input, and Productivity, Major Industry Groups Relative to Total Economy, 1929–65
(per cent per annum)

Major Industry Group	Output	Employment	Output Per Man	Output Per Unit of Labor Input	Output Per Unit of Total Factor Input	Compensation Per Man
Agriculture, forestry, and fisheries	−2.0	−3.5	1.5	0.8	0.5	0.6
Mining	−1.6	−2.4	0.7	0.6	−0.3	0.2
Contract construction	−0.9	0.3	−1.2	−1.1	−1.3	−0.2
Manufacturing	0.5	0.4	0.2	0.2	0.0	0.0
Transportation	−0.3	−1.8	1.4	1.2	1.3	0.2
Communications and public utilities	2.4	−0.1	2.6	2.2	1.8	0.4
Government enterprise	0.2	1.6	−1.4	−0.8	−0.7	−0.6
Wholesale and retail trade	0.0	0.3	−0.3	0.3	−0.2	−0.6
Finance, insurance, real estate, and services	−0.2	0.5	−0.7	−0.1	0.1	−0.6
Finance, insurance, and services excluding households and institutions	−0.6	0.7	−1.3	−0.5	−0.6	−0.8
General government	0.6	2.6	−2.0	−1.6	−1.7	−0.4

Source: Appendix Table C–3.

TABLE 18

Coefficients of Rank Correlation Between Rates of Change, 1929–47 and 1947–65, Across Ten Major Industry Groups

Measure	Coefficient of Rank Correlation
Output	.22
Employment	.81 [a]
Output per man	.72 [b]
Output per unit of labor input	−.09
Output per unit of total factor input	−.19
Compensation per man	−.34

Source: Appendix Table C–4.
[a] Statistically significant at .01 level of confidence.
[b] Statistically significant at .05 level of confidence.

the within-sector variance. Most of the industries in the Industry sector show high rates; contract construction is an outstanding exception, and government enterprise tends also to lag behind the rest of the sector. All of the service industries show below-average rates. It is interesting to note that every industry group that had a below-average rate of growth of compensation per man also was below average in growth of output per man, and a similar identity holds for industry groups with above-average rates.

Correlations Between Time Periods and Between Different Measures of Productivity

A comparison of the two subperiods, 1929–47 and 1947–65, shows considerable stability in the rankings of the industry groups with respect to rates of change of output per man (see Table 18).[15] The rankings are also very stable with respect to employment growth, but none of the other variables has significant coefficients of rank correlation and in three cases the sign is negative. These last three measures are particularly sensitive to nonequilibrium conditions in either the initial or terminal years. It seems likely that relative wages and prices in 1947 were distorted by the surge of demand during the war, the uneven impact of wage and price controls, and the dislocations of the period immediately

[15] The rank correlations are across ten industry groups. The finance, insurance, service group excluding households and institutions is used.

TABLE 19

Coefficients of Rank Correlation Between Changes in Output, Input, and Productivity, 1929–65, Across Ten Major Industry Groups

	Output	Employment	Output Per Man	Output Per Unit of Labor Input	Output Per Unit of Total Factor Input
Employment	.56	–	−.88 [a]	−.82 [a]	−.70 [b]
Output per man	−.18	−.88 [a]	–	.94 [a]	.92 [a]
Output per unit of labor input	−.09	−.82 [a]	.94 [a]	–	.95 [a]
Output per unit of total factor input	.05	−.70 [b]	.92 [a]	.95 [a]	–
Compensation per man	−.16	−.79 [a]	.88 [a]	.73 [b]	.71 [b]

Source: Table 17.
[a] Statistically significant at .01 level of confidence.
[b] Statistically significant at .05 level of confidence.

after the war. For these reasons, it is probably wise to concentrate the analysis on the full 1929–65 period.

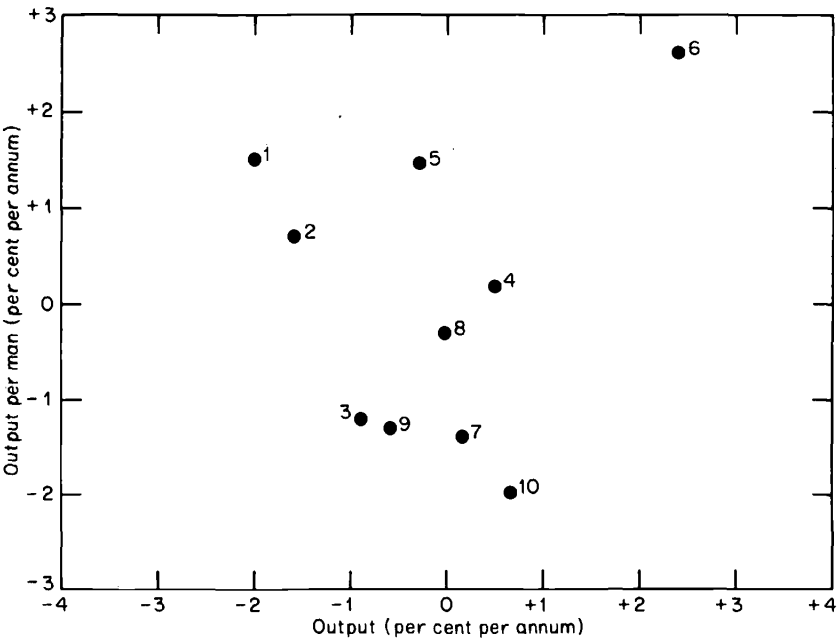
Table 19 shows that, for this period, there is a very high correlation among the three measures of productivity. In all cases the coefficient is above .90. If one is interested only in the rankings of the industry groups, it makes very little difference which measure is used. On the other hand, Table 17 shows that the actual differentials vary considerably from one measure to the other. In general, the intergroup variance is greatest for output per man and smallest for output per unit of total factor input. The median differential (without regard to sign) is 1.3 per cent per annum for output per man, 0.8 per cent for output per unit of labor input, and 0.6 per cent for output per unit of total factor input.

Several previous studies of industry productivity have found a high correlation between changes in output and changes in productivity, particularly over long periods.[16] Some of these studies have found even employment change to be positively correlated with productivity. Two

[16] See Solomon Fabricant, *Employment in Manufacturing, 1899–1939,* New York, National Bureau of Economic Research, 1942, pp. 88, 146; Kendrick, *Productivity Trends,* pp. 207–216; W. E. G. Salter, *Productivity and Technical Change,* Cambridge, England, 1960, p. 123; W. B. Reddaway and A. D. Smith, "Progress in British Manufacturing Industries in the Period 1948–54," *Economic Journal,* March 1960, p. 31.

CHART 4

Rates of Change of Output and Output Per Man, Ten Major Industry Groups Relative to the Total Economy, 1929–65



INDUSTRY LEGEND

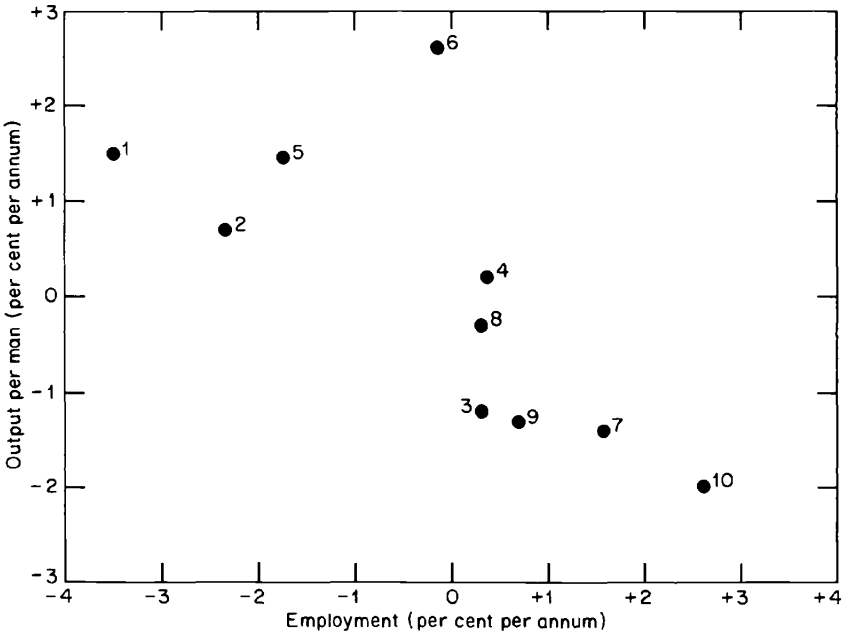
1. Agriculture, forestry, and fisheries
2. Mining
3. Contract construction
4. Manufacturing
5. Transportation
6. Communications and public utilities
7. Government enterprise
8. Trade
9. Finance, insurance, and services excluding households and institutions
10. General government

principal explanations have been offered for this relationship. First, it is argued that increased output (determined by income change, changes in taste, or variables exogenous to the industry) permits the realization of increased economies of scale, thus causing increased productivity. On the other hand, it is also claimed the industries with rapid gains in productivity show declines in relative prices which result in an increase in the quantity demanded and therefore an increase in output.[17]

[17] Michael Grossman has pointed out to me that a positive correlation between income elasticities and technological change would result in this relationship even if there were no economies of scale and zero price elasticities. Such a correlation might result if (1) the search for innovation was influenced by potential growth prospects, and (2) these prospects could be forecast.

CHART 5

Rates of Change of Employment and Output Per Man, Ten Major Industry Groups Relative to the Total Economy, 1929–65



Note: For industry legend see Chart 4.

The pattern of productivity change by major industry group is not consistent with these previous findings. There appears to be no significant relation between productivity change and change in output; the relation with change in employment is clearly negative (see Table 19 and Charts 4 and 5).[18] There is some element of spurious correlation to be sure, but in the case of output and productivity, the direction of the bias is positive. A finding of low or zero correlation, therefore, is all the more significant.

Most previous studies of this relationship were either limited to or highly dominated by manufacturing industries. In Chapter 4 the results for detailed industries within the Service sector are found to be similar

[18] Product-moment correlation coefficients are similar to the coefficients based on rank correlation. Between changes in output per man and output, the coefficients are +.13 (unweighted) and −.26 (weighted). Between changes in output per man and employment, the coefficients are −.74 (unweighted) and −.83 (weighted).

to those for manufacturing. Therefore, we are left with the tentative conclusion that growth and productivity do seem to be related across industries *within* major industry groups, but that no correlation is evident *across* major industry groups.

The comparison of productivity and growth across groups does not confirm previous studies. When we compare changes in productivity and compensation per man, the results again differ from those obtained in studies of manufacturing and those reported for trade and services in Chapter 4. Whereas studies across industries within major groups have not found any significant correlation between rates of change of productivity and of compensation per man,[19] the correlation across the ten major industry groups for 1929–65 is high and statistically significant (see Table 19 and Chart 6).[20]

The small number of observations and their aggregative nature must be noted. Certainly no firm conclusion is warranted on the basis of such limited data, but the results are suggestive. Most economists believe that rapid productivity gains in particular industries do not lead to particularly rapid wage gains in those industries, but are diffused broadly over the entire economy, especially if one looks at a reasonably long period. Earlier studies limited to or dominated by manufacturing have substantially confirmed this belief. One possible inference, therefore, is that differential change in labor quality has not been a major determinant of productivity change within manufacturing. The high correlation between productivity and compensation per man across major groups, on the other hand, suggests that differential trends in productivity have been associated with differential trends in labor quality.[21]

Quality of Labor

Portions of the preceding analysis suggest that differential change in the quality of labor may have been an important factor accounting for sector differences in the rate of growth of output per man.

Although it is difficult to define "labor quality" with precision, a few words concerning the use of the term in this book may be helpful. We know from casual observation that man-hours of labor are not homogeneous with respect to productivity. The effect of a given number of

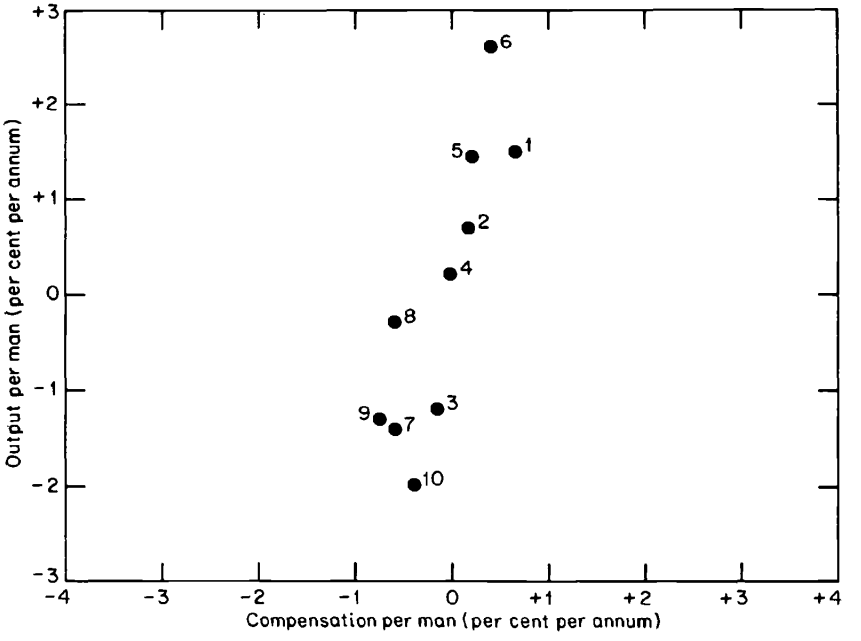
[19] See, for example, Kendrick, *Productivity Trends,* p. 198.

[20] The product-moment correlation between changes in output per man and compensation per man is .83 (unweighted) and .79 (weighted).

[21] An alternative inference—that the differential trends in compensation are a result of the weakness of competitive forces and are unrelated to labor quality—seems less plausible but cannot be rejected a priori.

CHART 6

Rates of Change of Compensation Per Man and Output Per Man, Ten Major Industry Groups Relative to the Total Economy, 1929–65



Note: For industry legend see Chart 4.

man-hours on output, holding technology and other inputs constant, is likely to vary depending upon such factors as the knowledge, intelligence, and strength of the persons supplying the hours of work. All of the factors that contribute to such variation are subsumed under the term "labor quality."

It is possible to measure some of the characteristics that we believe contribute to labor quality, such as age and number of school years completed. We can never specify all of the characteristics that might be related to quality, however, nor have we measures for many that we can name.

Table 16 indicates that the Industry-Service differential in the rate of change of compensation per man between 1929 and 1965 was .5 per cent per annum. As a first approximation, we may say that this more rapid rate of growth of compensation per man in the Industry sector is evidence of a more rapid rate of growth of the quality of labor in that

sector. This is subject to modification to the extent that the compensation per man differential can be explained by other factors. We consider a few of these now.

1. AVERAGE HOURS PER MAN. Some of the differential change in compensation per man may be attributable to a more rapid decline of average hours in Service than in the Industry sector. Previously accepted figures indicated that this differential might explain .3 percentage points of the differential in earnings per man.[22] This now appears to be an overestimate for two reasons. First, some new hours figures for manufacturing, estimated by Ethel Jones, suggest that the decline in manufacturing hours since 1929 had been understated, and David Schwartzman's new estimates for retailing suggest that the decline in that industry may have been previously overestimated (see footnote 5 above). Second, to the extent that hours in services were very long in 1929, the decline was probably partially offset by increased output per man-hour attributable solely to the decline in hours (see footnote 24 below).

Average weekly hours in each sector have been calculated for 1929 and 1965, using Kendrick's estimates in all instances except manufacturing (1929) and trade (1929 and 1965).[23] The Industry sector shows a decline from 47.2 hours to 39.7 hours. The Service sector shows a slightly greater decline from 50.8 hours in 1929 to 40.1 hours in 1965. The sector differential in rate of decline is approximately .18 per cent per annum. However, if Denison's formula for calculating a productivity offset to shorter hours is applied, the sector differential practically disappears.[24]

The above calculations suggest that the sector differential in compensation per man of .5 per cent need not be modified at all to take account of hours if one follows the Denison formula, or should be modified by about .2 percentage points if no allowance is made for a productivity offset. An allowance for a .1 percentage point differential trend in hours provides a compromise between these two positions.

2. CHANGES IN UNIONIZATION. One of the factors that might account

[22] See Victor R. Fuchs, *Productivity Trends in the Goods and Service Sectors,* p. 12.

[23] The data for the individual industry groups are presented in Appendix Table C-5.

[24] Denison, *Sources of Economic Growth,* p. 40. The Denison formula posits that, because of the adverse effects of fatigue, a decrease in hours when the level is above 48.6 per week is fully offset by an increase in output per man-hour. It is possible that fatigue is not as important in trade and services as in industry and therefore the productivity offset is not as likely. On the other hand, a decrease in the number of hours that the store is open is likely to produce a productivity offset through more intensive utilization.

for the more rapid rise of compensation per man in the Industry sector is union power. We know that unionization has grown rapidly in Industry since 1929, and that it has grown very slowly in the Service sector. In order to estimate the possible effect on compensation per man, we need measures of the extent of unionization in each sector in 1929 and 1965, and a measure of the union-nonunion differential in wages. Neither requirement can be filled with precision, but it is possible to obtain some notion of the possible order of magnitude of this effect.

The union effect on wages has been evaluated by H. Gregg Lewis as follows: "Apart from periods of unusually rapid inflation or deflation, the average relative wage effect of unionism . . . was 0.10–0.20 per cent per percentage point difference in extent of unionism." [25] Lewis views the union effect as more or less equal and continuous over the entire range from zero to 100 per cent unionization. Thus, if one industry were 100 per cent unionized, and another one completely unorganized, Lewis would expect a wage differential (adjusted for quality) of approximately 10 to 20 per cent. If one industry were 60 per cent unionized, and another one 20 per cent unionized, the expected differential would be 4 to 8 per cent.

In an analysis of interindustry differentials in hourly earnings, to be discussed in Chapter 6, I find a somewhat greater union effect; I also find that the effect is not equally strong at all levels of unionization. No union effect on wages is evident below 20 per cent unionization. The strongest effect, about .35 per cent per percentage point difference in unionization, is evident in the range 20 to 60 per cent unionized, after which the union effect is appreciably smaller and approaches zero for changes at high levels of unionization.

My analysis was based on data for 1959, a year when the union effect was probably particularly strong. The generally weak demand in the economy in 1958 and 1959 [26] tended to keep wages from rising in un-

[25] "The Effects of Unions on Industrial Wage Differentials," in *Aspects of Labor Economics,* Universities—National Bureau Conference 14, Princeton University Press for National Bureau of Economic Research, 1962, p. 332. Note that neither Lewis nor I am concerned here with the effect of unions on the general wage level. To the extent that the presence of unions in the economy raises wages generally, union power cannot be the source of a sector differential. Note also that Lewis and I are concerned with wages for a given quality of labor. If unions (or efforts to avoid them) produce higher wages in an industry, this may result in higher-quality labor being attracted to it, and may permit employers to be more selective in hiring. If a higher wage is offset by higher quality, it is not greater compensation in the relevant sense.

[26] The unemployment rate was 6.8 per cent in 1958 (the highest rate since 1941) and 5.5 per cent in 1959.

organized industries; the high profits and rising prices of the preceding capital goods boom provided the type of setting in which union demands are likely to be strongest and the differential between union and nonunion wages likely to be greatest. In applying the results of my estimate to 1965, a year of strong demand for labor, I would reduce the estimated union effect to .25 per cent per percentage point difference in extent of unionization over the range 20 to 60 per cent.

In order to apply the Lewis formula, it is only necessary to have the percentage of each sector's employment that was unionized in the initial and terminal years. In order to apply my formula, information is required about the distribution of industries by extent of unionization within each sector. In particular, it is necessary to know the percentage of the sector's employment in industries with unionization under 20 per cent and over 60 per cent, and to know the percentage unionized in the range 20 to 60 per cent. All the industries with unionization below 20 per cent or above 60 per cent are then set equal to 20 and 60, respectively.

Table 20 shows the change in the sector differentials in unionization between 1929 and 1960 according to both approaches. Detailed estimates of unionization by industry are not available for 1965; the 1960

TABLE 20

Extent of Unionization, Industry and Service Sectors, 1929 and 1960
(per cent of total employment)

	1929	1960	1960 Minus 1929
Unadjusted			
Industry	16	50	34
Service	2	8	6
Industry minus Service	14	42	28
Adjusted [a]			
Industry	24	48	24
Service	20	20	0
Industry minus Service	4	28	24

Source: 1929 figures, H. G. Lewis, *Unionism and Relative Wages in the United States*, Chicago, 1963; 1960 figures, see Appendix H.

[a] All industries with unionization below 20 per cent are set equal to 20; all with unionization above 60 per cent are set equal to 60. See Chapter 6.

figures are applied under the assumption that the sector differential in unionization remained unchanged between 1960 and 1965.[27] If we apply the midpoint of the Lewis estimate of the union effect, .15 per cent per percentage point, to the unadjusted change in the sector differential, 28 per cent, we obtain an estimate of 4.2 per cent ($.15 \times 28$) as the effect of the differential change in unionization on sector differences in earnings. This says that wages in the Industry sector relative to the Service sector in 1965 were 4.2 per cent higher than they would have been if the degree of unionization in each sector had remained the same as it was in 1929. Spread over thirty-six years, this represents an annual rate of change of .12 per cent.

Applying my estimate of .25 per cent per percentage point to the adjusted differential of 24 per cent changes the unionization effect to 6 per cent, or .16 per cent per annum. Taking both these results into account, and bearing in mind the crudeness of the estimates, one can draw the tentative conclusion that the effect of changes in unionization between 1929 and 1965 was to raise wages in the Industry sector relative to the Service sector at the rate of between .1 and .2 per cent per annum.

3. CHANGES IN NONPECUNIARY ADVANTAGES. A factor that may work in the opposite direction is nonpecuniary advantages not included in labor compensation. If these increased more rapidly in the Industry than in the Service sector, the compensation data understate the quality differentials; if they increased more rapidly in services the reverse is true. This assumes that industries that offer more nonpecuniary advantages, such as recreation programs, subsidized lunches, and in-plant health services, will be able to attract and hold better-quality workers. The data on changes in unionization imply that the change has been in favor of the Industry sector, given Lewis's judgment that "The relative gains won by unions probably consist partly of relative improvements in the nonpecuniary aspects of employment." [28]

One bit of evidence that points in this direction is the differential trend in supplements to wages and salaries. These supplements, per full-time equivalent employee, grew 1.6 per cent per annum faster in Industry

[27] It is possible that the differential narrowed as a result of unionization drives in hospitals, schools, and retail stores. If so, then the estimates presented here of the effect of unionization on differential earnings trends are biased upward.

[28] *Unionism and Relative Wages,* p. 46. Note also Melvin Reder's generalization that "As industries have shifted away from unskilled labor, they have also improved working conditions and reduced nonpecuniary disutilities." Melvin W. Reder, "Wage Differentials: Theory and Measurement," in *Aspects of Labor Economics,* p. 278.

than in the Service sector between 1929 and 1965.[29] It seems plausible that the industries that show relative improvement in their wage supplements were also experiencing relative improvement in nonpecuniary advantages.

4. CHANGES IN LOCATION OF INDUSTRY. Another factor tending to hold Industry wages down for given quality has been the shift of manufacturing away from the large industrial cities of the Northeast and North Central regions. Wages for workers of given color, age, sex, and education are considerably lower in small towns and in the South; indeed, this is one of the reasons why manufacturing has shifted.[30] This introduces a bias in the direction opposite to that introduced by changes in unionization.

To sum up, the growth of unions and differential changes in hours probably do bias the estimate of quality based on compensation, although there are possible offsets related to nonpecuniary advantages and changes in the location of manufacturing. If the assumptions and inferences described above are at all close to the mark, they suggest the sector differential trend in labor quality may have been approximately .3 per cent per annum, rather than the .5 per cent implied by the compensation data. There are undoubtedly other variables that might be considered, but it seems highly unlikely that these would alter the conclusion that there was a true differential trend in labor quality.

Additional Evidence on Labor Quality

The conclusion concerning differential trends in labor quality is supported by available evidence on changes in occupational and demographic characteristics of workers in the two sectors. A test of the significance of these factors must, unfortunately, be limited to the changes between 1950 and 1960 because comparable data are not available for earlier Census years.

We see in Table 21 that the relative importance of professional and managerial workers increased substantially in the Industry sector between 1950 and 1960, and declined slightly in the Service sector. The shift to these high-skill, high-earnings occupations is evident in every

[29] Calculated from Office of Business Economics data in Tables 6-1, 6-2, and 6-4 of *The National Income and Products Accounts of the United States, 1929–1965, Statistical Tables.*

[30] See Victor R. Fuchs, *Differentials in Hourly Earnings by Region and City Size, 1959,* New York, NBER, Occasional Paper 101, 1967; and *Changes in the Location of Manufacturing in the United States Since 1929,* New Haven and London, 1962.

TABLE 21

Professional and Managerial Workers as Percentage of All Occupations, by Sector and Major Industry Group, 1950 and 1960

	Professional, Technical, and Kindred Workers		Managers, Officials, Proprietors, Except Farm		Total Professional and Managerial	
	1950	1960	1950	1960	1950	1960
Industry, total	4.3	6.7	5.8	6.4	10.1	13.1
Service, total	15.6	17.7	14.4	12.1	30.0	29.8
Industry						
Mining	3.5	7.5	4.0	5.9	7.5	13.4
Construction	3.7	4.7	8.4	9.9	12.1	14.6
Manufacturing	4.9	7.7	4.8	5.2	9.7	12.9
Transportation, communications, and public utilities [a]	3.2	4.7	7.2	7.8	10.4	12.5
Service						
Wholesale trade	2.5	3.0	20.6	19.3	23.1	22.3
Retail trade	1.9	1.7	23.7	19.3	25.6	21.0
Finance, insurance, and real estate	3.3	3.4	16.9	17.6	20.2	21.0
Business and repair services	10.0	8.9	12.9	11.9	22.9	20.8
Personal services	5.0	4.5	10.9	9.9	15.9	14.4
Private households	0.7	0.3	0.0	0.0	0.7	0.3
Entertainment and recreation services	25.2	19.9	17.2	15.3	42.4	35.2
Professional and related services	61.3	57.1	2.5	2.8	63.8	59.9
Public administration	14.4	16.7	10.2	10.9	24.6	27.6

Source: U.S. Bureau of the Census, *Census of Population 1950*, "Occupation by Industry" and *Census of Population 1960*, "Occupation by Industry," Table 1.

[a] Includes postal service and other government enterprise.

group in the Industry sector, and was particularly pronounced in mining and manufacturing. In the Service sector there was a decline in the importance of professional and managerial workers relative to other occupations in every group except finance, insurance, and real estate, and public administration.

A quantitative estimate of the differential trend in labor quality can be obtained from data on demographic characteristics. We know that at any point in time there are substantial differences in hourly earnings across groups of workers classified by age and sex. These differences are thought to reflect, for the most part, differences in labor quality as perceived by employers, resulting from differences in experience, on-the-job training, labor force attachment, and so on. Table 22 shows average hourly earnings in 1959 for fourteen age-sex groups as estimated from the 1/1,000 sample of the *1960 Census of Population.*

Using Census of Population data for 1950 and 1960, it is possible to find the percentage distribution of employment in the Industry and Service sectors in each year by age and sex. These distributions, also shown in Table 22, are multiplied by the earnings rates to obtain weighted average earnings for each sector in each year. Changes in the weighted average reflect changes in the weights, i.e., they indicate the extent to which the age-sex distributions of workers in each sector moved in the direction of higher or lower earnings. By this criterion, the Industry sector improved by 1 per cent between 1950 and 1960, while the Service sector labor force worsened by 1 per cent. The differential change was 2 per cent, or approximately .2 per cent per annum.

The Industry sector has increasingly drawn its workers from males in the prime age groups, while the Service sector has become more dependent upon females, the very young, and the very old. In addition, there is some evidence that the education levels in the Industry sector have been rising more rapidly than in the Service sector.

The distribution of white males by years of schooling in each sector in 1950 and 1960, and average hourly earnings in 1959, are shown in Table 23. These distributions were estimated from distributions of major occupations by years of schooling and of sectors by major occupations.[81] Weighted averages are obtained in the same manner as in Table 22. They indicate that the average educational level showed 1 per cent more improvement in Industry than in Service between 1950 and 1960; that

[31] A check of this method against education-sector distributions obtained from the 1/1,000 sample of the *1960 Census of Population* indicated that it provides fairly reliable estimates.

TABLE 22

Average Hourly Earnings in 1959, by Age and Sex, and Percentage Distribution in Industry and Service Sectors, 1950 and 1960

Sex and Age	Average Hourly Earnings, 1959 (dollars)	Industry		Service	
		1950 (per cent)	1960 (per cent)	1950 (per cent)	1960 (per cent)
Males					
14–19	1.41	2.8	2.6	2.8	3.6
20–24	1.84	8.2	6.8	5.4	4.8
25–34	2.56	21.3	19.2	14.3	12.3
35–44	3.04	20.0	22.1	13.6	13.2
45–54	3.09	15.4	17.4	10.9	11.2
55–64	2.96	10.2	10.0	7.3	7.5
65 and over	2.83	3.1	2.4	3.4	3.2
Females					
14–19	1.34	1.3	1.0	3.6	3.5
20–24	1.54	3.4	2.3	6.0	4.9
25–34	1.74	5.2	4.1	9.2	7.5
35–44	1.74	4.5	5.6	9.8	10.1
45–54	1.77	2.9	4.3	7.8	10.3
55–64	1.75	1.3	2.1	4.4	6.0
65 and over	1.49	.3	.3	1.5	1.9
Weighted average (dollars)		2.53	2.56	2.28	2.26

Source: 1959 average hourly earnings and 1960 distribution in Industry and Service sectors calculated from 1/1,000 sample of *1960 U.S. Censuses of Population and Housing*. The 1950 distribution of employed persons in Industry and Service sectors from *1950 U.S. Census of Population*, Table 3, "Industrial Characteristics."

is, a differential rate of change of the educational component of quality of .1 per cent per annum.[32]

The differential changes in the age, sex, and educational distributions total .3 per cent per annum. The distribution by color was virtually un-

[32] It is important to distinguish between the rate of change of educational attainment and the actual levels at any fixed point. The rate of change has almost certainly been more rapid in Industry than in Service since 1929, but the level of educational attainment in Service has been higher than in Industry throughout the period. See Chapter 8.

TABLE 23

Average Hourly Earnings of White Males in 1959, by Years of Schooling, and Percentage Distribution in Industry and Service Sectors, 1950 and 1960

Years of School Completed	Average Hourly Earnings 1959 (dollars)	Industry		Service	
		1950 (per cent)	1960	1950 (per cent)	1960
0–4	1.95	6.6	4.2	4.9	3.2
5–8	2.40	36.1	29.1	27.0	21.8
9–11	2.58	22.2	24.3	18.6	20.4
12	2.78	23.0	26.1	24.6	25.8
13–15	3.33	6.6	8.7	11.1	13.0
16 and over	4.31	5.4	7.6	13.7	15.7
Weighted average (dollars)		2.66	2.75	2.87	2.94

Source: 1959 average hourly earnings from 1/1,000 sample of *1960 Censuses of Population and Housing*. Distribution of white employed males in Industry and Service sectors estimated from *1950 and 1960 Censuses of Population*, "Occupation by Industry," and "Occupation by Earnings and Education."

changed in both sectors between 1950 and 1960; therefore, .3 per cent represents the best estimate of the differential change in labor quality as revealed by demographic characteristics. It is approximately the same rate as that implied by differential change in compensation per man, 1929–65, adjusted for changes in hours and unionization.

Why should labor quality have increased more rapidly in Industry than in the Service sector? Possible explanations include the following:

1. A factor bias in the type of technological change occurring in the two sectors which increased the demand for skilled labor in Industry relative to Service.

2. A complementarity between labor quality and physical capital. The latter, as we shall see, has tended to grow more rapidly in the Industry sector, and the skilled labor may be needed to handle the more complex plant and equipment.

3. Sector differences in the elasticity of substitution between skilled and unskilled labor or between capital and unskilled labor. The price of the latter has tended to rise relative to skilled labor and capital, and firms in the Industry sector may have found it easier to substitute for unskilled labor.

4. Sector differences in the rate of growth of the price of unskilled labor. This price may have risen particularly rapidly in the Industry sector because of unionism and minimum wage legislation.

Whatever the reason, there is little doubt that the amount of human capital embodied in each worker rose more rapidly in Industry than in the Service sector since 1929. Furthermore, this differential was an important source of the sector differential in the growth of output per man.

Physical Capital and the "Residual"

Physical Capital Per Worker

The calculation of sector trends in labor input is difficult, but the problems encountered are trivial compared with those surrounding measures of physical capital. With respect to the latter, economists are not yet agreed on the "ideal" method; but even if they were, the paucity of data for early years makes it impossible to offer anything but rough impressions.

In the following discussion, use is made of two alternative estimates of the sector differential in the rate of growth of capital input, 1929–65. These alternative estimates, in my judgment, provide outer boundaries within which the true differential probably falls.

The lower boundary of the Industry-Service differential is obtained by assuming that capital per worker grew at the same rate in the two sectors.[33] This probably underestimates the differential because it is generally assumed that capital per worker grew more rapidly in Industry than in the Service sector. If we assume no differential trend in capital per worker, the differential trend in capital input is equal to the differential trend in employment, which is −.9 per cent per annum for Industry minus Service.

The upper boundary is obtained by assuming that output per unit of capital input grew at the same rate in the two sectors.[34] This probably overstates the differential because it is likely that there was some differential in capital productivity.[35] If we assume no differential trend in out-

[33] Some rough support for the notion that there was not much differential in the rate of growth of capital per worker can be found in estimates based on data from the Internal Revenue Service for 1929 and 1960. See Appendix D.

[34] Some rough estimates that seem to support this assumption can be found in capital stock figures presented by Bert G. Hickman for the 1945–62 period, in *Investment Demand and U.S. Economic Growth,* Washington, D.C., 1965, pp. 230–231. See Appendix D.

[35] The "residual" is larger for Industry than for Service (see Table 24), suggesting that technological change has been more rapid in Industry.

TABLE 24

Sector Differentials in Rates of Growth of Output Per Unit of Labor and Capital, Under Alternative Assumptions, 1929–65
(per cent per annum)

	Output	Labor Input	Capital Input [a]	Input of Labor and Capital Combined [b]	Output Per Unit of Labor and Capital Combined
Industry minus Service					
First alternative	.3	−.3	−.9	−.4	.7
Second alternative	.3	−.3	.3	−.2	.5
Industry minus Service subsector					
First alternative	.5	.2	−.4	.0	.5
Second alternative	.5	.2	.5	.3	.2

Source: See text and Appendix D.

[a] Assuming capital per worker (first alternative) or capital productivity (second alternative) changed at the same rate in both sectors.

[b] A weighted average with labor = 3 and capital = 1.

put per unit of capital, the differential trend in capital input is equal to that in output, which is .3 per cent per annum for Industry minus Service.

These alternative approaches yield an uncomfortably large range. But even the extreme values yield estimates of the residual that are not too far apart, because the Cobb-Douglas production function weights capital and labor according to their shares in national income, and capital's share has typically been only about 25 per cent. Using weights of 1 to 3, the sector residual is calculated and shown in Table 24.[36]

These calculations reveal that the sector differential in output per unit of labor and capital combined was probably about .6, with a margin of error of .15 in either direction. Similar estimates were made for Industry minus Service subsector, and they indicate a differential rate of change

[36] For more precise estimates, different weights should be used for each sector, but some experimentation with differences as large as 1 to 2 for Industry and 1 to 4 for Service, reveals that the assumption of equal weights for both sectors does not affect the results in the first decimal place. However, none of the estimates can be regarded as being accurate beyond one decimal place.

of output per unit of capital and labor combined of approximately .35, with a margin of possible error of about .15 in either direction.

These estimates of the differential trend in total factor productivity should be compared with the differential trends in output per man of 1.1 per cent and 1.0 per cent per annum for Industry minus Service and Industry minus Service subsector, respectively.

The results of Table 24 may also be compared with the estimates of output per unit of total factor input inferred from the rates of change of the implicit price deflators. This approach yields differentials of .4 per cent per annum and .5 per cent per annum, respectively.

The differential trend in output per unit of labor and capital combined, or per unit of total factor input, corresponds to the well-known "residual." It indicates the approximate importance of differential trends in technology and economies of scale. It may also reflect biases in the measures of output or factor input. Putting the question of bias aside for a moment, our best estimate of the Industry minus Service residual is .5 per cent per annum.

Possible Biases in Measurement of Residual

The residual can be biased by errors in measurement of the differential trends in output or input. We have already seen that there is probably a bias of .1 per cent per annum in the labor input differential as inferred from labor compensation. Industry sector wages, relative to the Service sector, have been raised by at least that amount because of the differential trend in unionization. Inasmuch as labor input constitutes about three-fourths of total factor input, the latter differential is also biased by about .1 per cent per annum.

Considerable critical attention has been given to the downward bias in the measurement of service output resulting from the arbitrary assumption of no productivity advance in government and some related nonprofit activities. This criticism seems to be justified. Detailed studies of selected activities of the federal government have revealed significant advances in output per man-hour.[37] Years ago, Solomon Fabricant spelled out in detail many reasons why some upward trend in government productivity should be expected.[38]

The rapid rate of expansion of government activity (especially that

[37] See *Measuring Productivity of Federal Government Organizations*, Bureau of the Budget, Washington, D.C., 1964.

[38] Solomon Fabricant, *The Trend of Economic Activity in the United States Since 1900*, New York, National Bureau of Economic Research, 1952, especially Chapter 5.

of local and state governments) in itself sets up a presumption in favor of some productivity advance. As we shall see in the next chapter, there is a positive correlation between rates of growth of productivity and rates of growth of employment for seventeen service industries where an independent measure of output is available. The striking point is that the rates of growth of employment in government and other service industries for which we do not have an independent measure of output were much more rapid than for the seventeen industries. Thus, if a similar relationship held for all service industries between productivity and employment, the true rates of growth of output for the industries where zero productivity change is assumed are being seriously underestimated.

Those industries account for about one-third of the total Service sector employment. If their rate of growth of output is being underestimated by, say, 1.0 per cent per annum,[39] then the Industry-Service differential trend is biased by about .3 per cent per annum.

It is unwise, however, to conclude that this is the only bias in the measurement of the sector differential in output. Two other important matters must be considered. First, there is the possibility of a strong upward bias in the measurement of real output in retail trade. Second, there is the likelihood of some important downward biases in the measurement of output in the Industry sector, notably in construction and government enterprise.

The probable bias in retail trade is discussed in Chapter 5. David Schwartzman has argued that there has been a significant decline in the quantity and quality of service *supplied by retailers* per unit of goods sold. Part of this decline represents no diminution in service as perceived by consumers because it has been offset by services supplied by manufacturers. These include product information, guarantees, return and repair services, better control of quality and size, etc. Part of the decline has been offset by consumer-supplied services, such as selection of purchases, delivery, and storage. Schwartzman argues that the price of retail service has risen relative to other prices, and that consumers have therefore tended to substitute goods for retail service. The supermarket and other low-margin retail operations cannot be regarded as technological advances since they were part of the "state of the art" in 1929. They came into wide use as a result of the rise in the price of retail service and the growth of automobile ownership.

Over the period under study, retail trade accounted for as large a share of employment as did government. Thus, an upward bias of, say,

[39] This is the approximate rate of growth of output per man for the Service subsector where some independent measures of output are available.

1 per cent per annum in retailing (Schwartzman estimates the bias as above that level) would tend to offset a similar downward bias in government.

Another offsetting bias is the probable underestimation of the growth of output in construction.[40] This industry accounts for one-eighth of the Industry sector. A bias of even 1 per cent per annum could affect the sector rate of growth of output by more than .1 per cent per annum.

There are undoubtedly other biases present in the measurement of output in both sectors.[41] Most output indexes fail to capture changes in quality; this would be true for medical care as well as for nonstandardized manufacturing output. However, to the extent that quality improvement takes the form of *new* services or products, e.g., open-heart surgery or television sets, there is no satisfactory way of entering such changes into the analysis and, indeed, such changes are not accounted for in studies of output and productivity in the economy as a whole.

The problem of measuring service output relative to industry output is far from solved, but the above consideration of various biases leads to the tentative conclusion that the differential trend implied by the Office of Business Economics figures on deflated gross product may not be far from the truth. If there is some understatement of the trend in Service output relative to Industry, it probably is not large, perhaps on the order of .1 or .2 per cent per annum. It almost certainly is small relative to the observed differential trend in output per man of 1.1 per cent per annum, and can be dismissed as the major explanation of this differential.

Reexamination of the Shift to Service Employment

This chapter has concentrated on differential trends in productivity in the Industry and Service sectors between 1929 and 1965. The results can be applied to the original question posed at the end of Chapter 2: Why has employment grown so much more rapidly in Service than in Industry? The reader is again reminded that many of the measures used are imperfect; the following conclusions must, therefore, be regarded as indicating orders of magnitude rather than precise results.

1. Over the period studied, employment grew .9 per cent per annum

[40] See, for example, Douglas Dacy, "Productivity and Price Trends in Construction Since 1947," *Review of Economics and Statistics,* November 1965.

[41] The growth of real output in commercial banking is almost surely understated. See John A. Gorman, "Alternative Measures of Real Output and Productivity in Commercial Banks," in *Production and Productivity in the Service Industries,* V. R. Fuchs, ed., NBER, in press.

faster in Service than in Industry. *None* of this increase can be explained by a shift of final output to services. In fact, the OBE figures on deflated gross product originating show a differential trend in output in favor of Industry of about .3 per cent per annum. Correction for possible biases might reduce this by .1 or .2 per cent per annum.

2. About .1 percentage point per annum of the differential can be accounted for by a faster decline of hours in Service than in Industry. The actual differential trend in hours was somewhat greater than this, but was probably offset in part by an inverse correlation between changes in productivity and average weekly hours when weekly hours are very long.

3. About .3 percentage points per annum can be accounted for by a more rapid rise in the quality of labor in Industry than in Service. This is the differential implied by changes in demographic characteristics between 1950 and 1960. The sector differential in compensation per man, 1929–65, was .5 per cent per annum, but .2 percentage points of this is probably explained by changes in hours and unionization, and .3 percentage points by labor quality. Of all the variables identified, labor quality is probably the most important one in explaining the differential trend in employment.

4. About .1 or .2 percentage points per annum can be accounted for by the more rapid rise of capital per worker in Industry than in Service.

5. The unexplained portion of the differential trend in employment (the "residual") is about .4 or .5 per cent per annum. This differential is probably attributable to a faster rate of technological change in Industry, or to the realization of greater economies of scale in that sector.

Although the analysis presented in the chapter does support the hypothesis that productivity (however measured) has increased more rapidly in Industry than in Service, it refutes the notion that productivity does not grow at all in the service industries. A more detailed look at the extent and variability of gains in service productivity is presented in the next chapter.