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Changes in Productivity

We are now ready to turn to the productivity measures themselves. All changes are expressed as annual rates (compounded) between the initial and terminal years.[1] 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.[2]

We have not attempted to measure in absolute terms two of the variants of productivity: output per unit of labor input and output per unit of total factor input. The calculation of reliable measures in absolute terms for these variants would require a great deal of effort and is not central to the purpose of this paper. Instead, we calculate for each sector rates of productivity change relative to the economy as a whole, as well as the rates of change of the goods sector relative to the service sector.

Sector Comparisons of Productivity Change

Rates of change of output per man and output per man-hour are presented in Table 2. The latter are higher than the former in all cases, reflecting the general decline in hours per man since 1929. This decline was much steeper before 1947 than since, and was much more pro-

[1]The use of terminal years to calculate trends, rather than the fitting of a trend line through annual observations, greatly simplifies the task of calculation and apparently makes little difference in the results. Complete annual data are not available for the entire period, but we have compared the two methods of calculating sector differentials in output per man for 1947-61 and we find that the results are quite similar.

[2]Calculation of ratios of output and input indexes and the conversion of these ratios into annual rates would be more precise, but the difference in results is insignificant for rates of change of the magnitude examined in this paper.

nounced in the service sector than in goods. Productivity gains since 1947 have been more rapid than before, with the notable exception of output per man-hour in the service sector.[3]

Table 3 presents the rates of change of output per unit of labor input and per unit of total factor input in relative terms. Each measure shows the difference between the rate for the particular sector and the rate for the economy as a whole (whatever that rate might be). In order to emphasize the relative nature of these measures, they have been preceded by a plus or minus sign. A plus indicates that productivity grew more rapidly in the industry than in the economy as a whole; a minus sign indicates the reverse.

Our principal interest is in the differentials in rates of change between the two sectors; these are summarized for all four variants of productivity in Table 4. We note, first, the differential referred to at the beginning of this paper—namely, that output per man in goods grew 1.7 per cent per annum faster than in service. It is this differential that constitutes, in one sense, the "to be explained."

A look at the modified sectors shows that the differential is smaller. The exclusion of agriculture lowers the productivity-per-man rate for goods and the exclusion of government raises the rate for the service sector. The exclusion of government raises the service sector rate because output per man, as presently measured, rose more rapidly in the service industries other than government. The exclusion of agriculture lowers the rate of productivity for goods primarily because of the intrasector shift effect; i.e., agriculture, an industry with low gross product per man, became less important over time. The last two rows present the sector differentials after attempting to eliminate the intrasector shift effect.[4]

A partial explanation for the large intersectoral differential in output per man emerges as we look at the other variants of productivity. Close to .4 percentage points disappears if we take account of average hours worked as well as employment. This means that hours per week in the service industries have, on average, been decreasing .4 per cent per annum faster than in the goods industries. Most of this differential decrease occurred before 1947.

[3]The tables in the text show the rate of change between 1929 and 1961. Comparable figures for the subperiods 1929-47 and 1947-61 can be derived from Tables A-1 and A-2.

[4]To be discussed in this section.

TABLE 2

RATES OF CHANGE OF OUTPUT, EMPLOYMENT, MAN-HOURS, AND PRODUCTIVITY, GOODS AND SERVICE SECTORS, 1929-61
(per cent per annum)

	Output	Employment	Man-Hours	Output per Man	Output per Man-Hour
All industries	2.79	1.17	.53	1.62	2.26
Goods	2.80	.36	-.12	2.44	2.92
Service	2.79	2.09	1.22	.70	1.57
Goods*	3.08	1.03	.56	2.05	2.52
Service*	2.54	1.79	.94	.75	1.60

Note: For sector definitions, see note to Table 1.
Source: Table A-2.

TABLE 3

RATES OF CHANGE OF OUTPUT, LABOR INPUT, TOTAL FACTOR INPUT, AND PRODUCTIVITY, GOODS AND SERVICE SECTORS RELATIVE TO TOTAL ECONOMY, 1929-61
(per cent per annum)

	Output	Labor Input[a]	Total Factor Input[b]	Output per Unit of Labor Input	Output per Unit of Total Factor Input
Goods	+.01	-.32	-.20	+.33	+.21
Service	.00	+.34	+.20	-.34	-.20
Goods*	+.29	-.14	+.07	+.43	+.22
Service*	-.25	-.23	+.15	-.02	-.40

Note: For sector definitions, see note to Table 1.
Source: Table A-2.

[a]Based on labor compensation.

[b]Based on gross product in current dollars.

TABLE 4

DIFFERENCES IN RATES OF CHANGE OF PRODUCTIVITY BETWEEN THE GOODS AND SERVICE SECTORS, 1929-61
(per cent per annum)

	Output per Man	Output per Man-Hour	Output per Unit of Labor Input	Output per Unit of Total Factor Input
Sector aggregates				
Goods minus service	1.74	1.35	.67	.41
Goods* minus service*	1.30	.92	.45	.62
Fixed-weight average[a] of industry groups				
Goods minus service	1.40	1.04	.64	.51
Goods* minus service*	1.33	.94	.45	.67

Note: For sector definitions, see note to Table 1.
Source: Tables 2, 3, and A-2.

[a]The rate of change of productivity of each industry group is weighted by the average of its share of output and input in 1929 and 1961.

Approximately another .5 per cent of the differential disappears if we look at output per unit of labor input instead of output per man-hour. This suggests that labor quality may have been an important factor accounting for the sector differences in rate of growth of output per man. We will discuss this hypothesis in some detail in Section 4.

The effect of taking into account total factor input is mixed, reducing the differential further for the full sector comparison and increasing it for the modified sectors. On balance, the change is not large. This suggests that sector differentials in growth of capital were probably not a major factor influencing the differential rate of growth of output per man. Direct estimates of trends in capital per worker and a discussion of their possible effects on productivity are presented in Section 5.

The pattern of sector differentials for 1929-47 and 1947-61 is generally similar to that for the over-all period. The absolute differentials tend to be larger in the postwar years, but it should be recalled that the absolute rates of productivity advance were at a higher level since 1947.

TABLE 5

RATES OF CHANGE OF OUTPUT, EMPLOYMENT, AND PRODUCTIVITY, MAJOR INDUSTRY GROUPS RELATIVE TO TOTAL ECONOMY, 1929-61
(per cent per annum)

	Output	Employment	Output per Man	Output per Man-Hour	Output per Unit of Labor Input	Output per Unit of Total Factor Input
Goods Sector						
Agriculture, forestry, and fisheries	-1.79	-3.03	+1.24	+.94	+.71	+.35
Mining	-1.46	-2.38	+.92	+.57	+.67	-.57
Contract construction	-.79	+.68	-1.47	-1.79	-1.18	-1.36
Manufacturing	+.34	+.15	+.19	-.02	+.18	-.08
Transportation	+.27	-1.71	+1.98	+2.03	+1.90	+2.05
Communications and public utilities	+3.00	-.09	+3.09	+2.94	+2.70	+2.39
Government enterprise	+.52	+1.47	-.95	-.96	-.31	+.12
Service Sector						
Wholesale and retail trade	-.20	+.55	-.75	-.57	+.09	-.53
Finance, insurance, real estate, and services	-.18	+.34	-.52	-.26	-.02	+.35
(Finance, insurance, and services excluding households and institutions)	(-.34)	(+.73)	(-1.07)	(-.81)	(-.20)	(-.21)
General government	+1.14	+2.82	-1.68	-1.95	-1.17	-1.62

Source: Table A-2.

Productivity by Major Industry Group

The discussion thus far has been entirely in terms of sector totals; it is now time to look at productivity change in the individual industry groups that make up the two sectors. We are mindful of the conclusion reached by Stigler at the end of his study of employment in the service industries. He wrote, "no simple rule describes the trend of employment in the promiscuous ensemble of service industries. . . . Responsible pre-

dictions of trends in this large area will not be possible until we have pushed much further in the study of individual industries."[5]

Table 5 presents relative output, employment, and productivity measures for each of the major industry groups. The figure for each group shows the difference between the rate for that group and the rate for the total economy. 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 2.5 times as large as the within-sector variance. Most of the industries in the goods sector show high rates; contract construction is an outstanding exception and government enterprise tends also to lag behind the rest of the sector. Most of the service industries show low rates. There is considerable correlation between the various productivity measures, as may be seen in the first entries in Table 6.

Relation Between Changes in Productivity and Changes in Output, Employment, and Hourly Compensation

Several previous studies of industry productivity have found a high correlation between changes in output and changes in productivity, particularly for long periods.[6] Some of these studies have found even employment change to be positively correlated with productivity. Two principal explanations have been offered for this relationship. First, it is argued that increased output (determined by income change, changes in taste, or other 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 that industries with rapid gains in productivity show declines in relative prices, which result in an increase in the quantity demanded and therefore increased output.

[5] *Employment in the Service Industries*, p. 166.

[6] 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, 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.

TABLE 6

COEFFICIENTS OF RANK CORRELATION BETWEEN CHANGES, 1929-61, IN PRODUCTIVITY AND IN OTHER MEASURES ACROSS MAJOR INDUSTRY GROUPS

	Output per Man	Output per Man-Hour	Output per Unit of Labor Input	Output per Unit of Total Factor Input	Output	Employment	Man-Hours	Compensation per Man-Hour
Output per man	—	.99	.98	.82	-.01	-.84	-.86	.87
Output per man-hour	—	—	.99	.79	-.06	-.86	-.88	.88
Output per unit of labor input	—	—	—	.78	-.01	-.82	-.86	.83
Output per unit of total factor input	—	—	—	—	.22	-.49	-.53	.71
Output	—	—	—	—	—	.49	.48	-.19
Employment	—	—	—	—	—	—	.99	-.84
Man-hours	—	—	—	—	—	—	—	-.83
Compensation per man-hour	—	—	—	—	—	—	—	—

Note: Number of industries = 10. Correlations larger than .56 are statistically significant at the 5 per cent level of confidence. Correlations larger than .74 are statistically significant at the 1 per cent level of confidence.

Source: Tables 5 and A-2.

The measures of productivity change by industry presented in Table 5 are 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 6 and Figures 1 and 2.) 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.

Research aimed at reconciling these results with those of previous studies might consider the fact that the latter were either limited to or heavily dominated by manufacturing industries. The highly aggregative nature of the industry groups should also be noted. One possibility is that the forces that are operative within manufacturing are not as important in other industry groups. It is possible also that results similar to those recorded for manufacturing would be found *within* each of the other groups, but not across the groups. Some preliminary investigations by David Schwartzman indicate that change in output and productivity change *were* correlated across ten retail trades.

Our comparisons of productivity and output do not confirm the correlations reported in previous studies. When we compare changes in productivity and in compensation per man-hour, however, the opposite results are obtained. Whereas previous studies have reported no significant correlation between these variables,[7] we find that the correlation across the ten major industry groups for 1929 to 1961 was high, +.88 and +.71. (See Table 6 and Figure 3; see Table 7 for actual levels of compensation per man-hour and rates of change by industry group.)

The small number of observations and their aggregative nature must again be noted. Certainly no firm conclusion is warranted on the basis of such sketchy 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

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

been a major determinant of productivity change within manufacturing. The high correlation across major groups, on the other hand, suggests that differential trends in productivity have been associated with differential trends in labor quality.[8]

The Effect of Intrasector Shifts

The sector differentials presented in the first two rows of Table 4 are based on treating each sector as an aggregate. They reflect, therefore, the effects of the changing importance of industries within each sector, as well as the rate of change of productivity of the individual industry groups. If, within a sector, the industries with high *levels* of productivity are growing in relative importance, the sector will tend to show a high rate of growth of productivity even though the individual industries may have only average or below-average rates of change of productivity. The last two rows of Table 4 present another set of sector differentials for which we have attempted to eliminate the effect of such intrasector shifts. These sector measures are fixed-weight averages of the rates of change of the individual industry groups.[9]

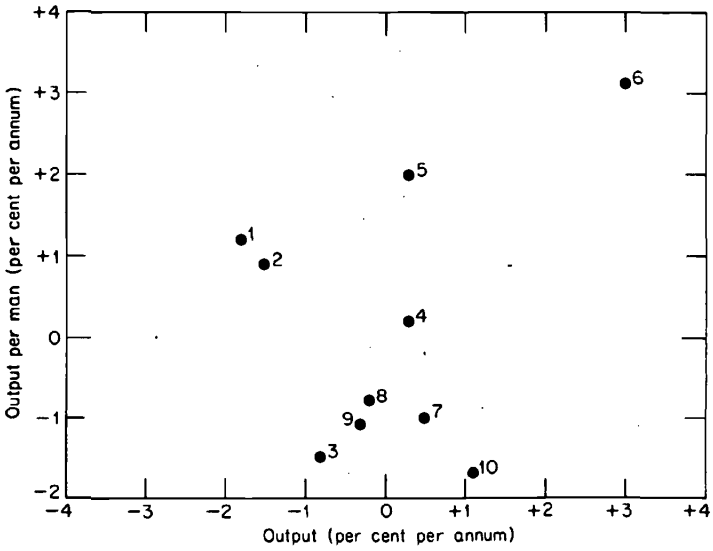
Comparison of the two sets reveals that the differentials for the modified sectors are almost identical. This means that no significant part of the differential can be attributed to intrasector shifts. For the unmodified sectors, the output per man and output per man-hour differentials are significantly smaller for the fixed-weight averages than for the sector aggregates. This indicates that a portion of the differential

[8]The 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.

[9]The rate of change of productivity of each industry group is weighted by the average of its share of output and input in 1929 and 1961. Such attempts at standardization can never yield a completely satisfactory solution because of familiar index-number problems. We have used average weights in order to give results similar to those that would be obtained if we averaged the results of all the alternative standardization procedures.

FIGURE 1

Rates of Change of Output and Output per Man, Ten Major Industry Groups Relative to Total Economy, 1929-61



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

FIGURE 2

Rates of Change of Employment and Output per Man, Ten Major Industry Groups Relative to Total Economy, 1929-61

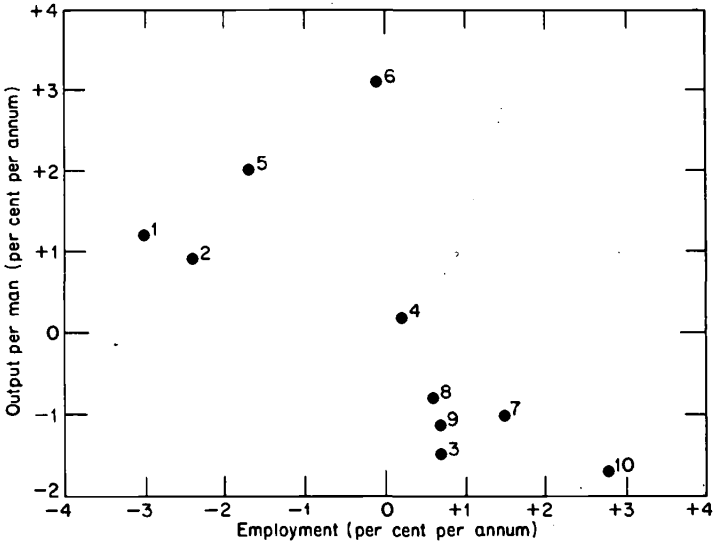


FIGURE 3

Rates of Change of Compensation per Man-hour and Output per Man, Ten Major Industry Groups Relative to Total Economy, 1929-61

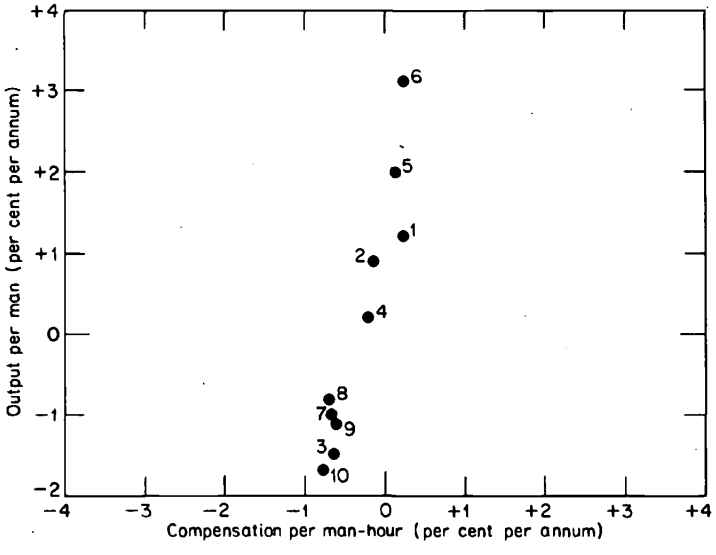


TABLE 7

COMPENSATION PER MAN-HOUR BY SECTOR
AND MAJOR INDUSTRY GROUP, 1929-61

	1929 (dollars)	1961 (dollars)	Annual Rate of Change (per cent)
Goods	.52	2.77	5.36
Service	.57	2.43	4.62
Goods*	.71	3.18	4.81
Service*	.60	2.33	4.34
Agriculture, forestry, and fisheries	.17	.86	5.24
Mining	.74	3.39	4.88
Contract construction	.80	3.16	4.37
Manufacturing	.71	3.15	4.79
Transportation	.67	3.31	5.13
Communications and public utilities	.64	3.30	5.25
Government enterprise	.82	3.19	4.32
Trade	.57	2.20	4.31
Finance, insurance, real estate, and services	.51	2.24	4.75
(Finance, insurance, and services excluding households and institutions)	(.66)	(2.58)	(4.37)
General government	.84	3.14	4.22

Note: Employees only. For sector definitions, see note to Table 1.
Source: Compensation and employment, U.S. Department of Commerce, Office of Business Economics; hours, Kendrick, Productivity Trends, (with extrapolations and interpolations).

for the latter is attributable to intrasector shifts in the relative importance of the industry groups. In particular, part of the productivity gain of the goods sector is because agriculture, an industry with low gross product per man, has become less important over time. Since agriculture was not particularly low in output per unit of labor input, the shift effect is not noticeable in that productivity comparison.