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PRODUCTIVITY DIFFERENCES
WITHIN THE SERVICE SECTOR:
A STATISTICAL ANALYSIS

This chapter and the following one are concerned primarily with differential trends in productivity within the Service sector. Whereas the previous chapter was focused at a highly aggregative level, the present one attempts to study productivity at a much finer level of industry detail. Such an approach has some clear limitations. It will not be possible to include all the service industries. Moreover, the danger of errors in the data may be greater than when we work with sector aggregates or broad industry groups; generalizations can be made only with the greatest caution. Nevertheless, we know from preliminary study that substantial differences in rates of growth of productivity exist within the Service sector. It may be that an analysis of such differences will provide some insight as to why services as a group tend to improve their output per man less rapidly than do other industries. Also, the analysis of interindustry differences in productivity within the Service sector can serve as a check on conclusions that have been reached from the study of interindustry differences within goods-producing industries. There are a number of important conceptual problems concerning the measurement of output and input in service industries which are likely to be brought out more clearly by a consideration of detailed industries. Finally, the analysis of changes in productivity over time in selected service industries may provide some guidance for the study of intercountry differences in productivity at a given point in time.

In this chapter, differential trends in productivity are examined across eighteen service industries from 1939 to 1963. The analysis is largely statistical in nature, relying heavily on correlation and regression techniques. No attempt is made to explore any particular industry in depth; Chapter 5 does precisely that: it contains a more detailed examination of productivity in personal services, retailing, and medical care.

Scope, Definitions, and Sources

The service industries discussed in this chapter are shown in Table 25. They include all of retailing, divided into ten retail trades, and eight services, mostly of the "personal service" category. Together, they account for 17 per cent of total U.S. employment in 1963, 30 per cent of Service sector employment, and 51 per cent of Service sector employment excluding government, households, and institutions.

The industries chosen were those for which there was sufficient data to obtain reasonably comparable measures of output and input for selected years during the period 1939–63.¹ Also, they are industries for which it is possible to calculate a measure of real output that is not based on labor input. It is widely recognized that where real output is estimated from labor input, as in government and much of the households and institutions categories, analysis of productivity change is scarcely possible. The selected industries' rates of growth of employment were considerably below the rate for the rest of the Service sector.²

A summary of the definitions, methods, and sources follows. Detailed information, as well as the raw data, are provided in Appendix G.

Real Output

For the eight services, real output was defined as receipts in constant (1954) dollars. These were estimated from receipts in current dollars, as reported in the *Census of Business*, deflated by components of the Consumer Price Index published by the Bureau of Labor Statistics (BLS).³ To the extent that the price indexes take account of changes in the quality of services rendered, the real output measures do also.

For the ten retail trades, real output was assumed to change at the same rate as the volume of sales of goods in real terms. This was estimated from receipts by type of store, in current dollars (as reported in the *Census of Business*), deflated by price indexes prepared by David Schwartzman at the National Bureau. Because of differences in the combination of price indexes used to calculate the average price index by store type, in a few instances the deflators differ from those used by the

¹ The most recent *Census of Business* was conducted in 1963. The earliest Census year with comparable data for both trade and services was 1939.

² For 1939–63, aggregate employment in the selected industries grew at a rate of 1.9 per cent per annum compared with 3.2 per cent for the rest of the Service sector. For the period 1948–63, the rates were 1.1 and 3.0 per cent, respectively.

³ Prices for hotels and motels were obtained from Horwath and Horwath, *Hotel Operations in 1963*.

TABLE 25

Level of Employment and Percentage of Total U.S. Employment
in Eighteen Selected Service Industries, 1963

Industry	Level of Employment (thousands)	Percentage of U.S. Total
Services		
Auto repair	414	.61
Barber shops	180	.27
Beauty shops	345	.51
Dry cleaning	268	.40
Hotels and motels	544	.80
Laundries	346	.51
Motion picture theaters	106	.16
Shoe repair	34	.05
Total	2,238	3.30
Retail trades		
Apparel stores	659	.97
Automobile dealers	860	1.27
Drug stores	365	.54
Eating and drinking places	1,933	2.85
Food stores	1,490	2.20
Furniture and appliances	459	.68
Gasoline stations	682	1.01
General merchandise	1,434	2.12
Lumber dealers	466	.69
Other	870	1.28
Total	9,217	13.60
Total, 18 selected service industries	11,455	16.90

Source: U.S. Bureau of the Census, *1963 Census of Business*. Coverage details are in Appendix G. U.S. employment is the number of persons engaged in production from U.S. Department of Commerce, *The National Income and Product Accounts of the United States, 1929-65, Statistical Tables*.

Office of Business Economics. Schwartzman's indexes were based on detailed commodity components of the BLS Consumer Price Index weighted by the importance of each commodity in each store type as reported in the *1948 Census of Business*. The BLS price indexes for retail sales of commodities do not allow for changes in quality of service rendered by retailers.⁴

The real output measures for the eighteen industries should be considered only as approximations; they are not exactly equivalent either to the gross measures of physical output that are possible for some goods industries or to the estimates of real gross product originating that would be obtained through separate deflation of outputs and inputs.

Employment

The basic employment concept used is "persons engaged" as defined by the Office of Business Economics of the U.S. Department of Commerce. This is estimated from *Census of Business* data on employment and payrolls, with part-time wage and salary employees converted to full-time equivalents by assuming that their share of total wage and salary employment is equal to their share of total payroll. In addition to wage and salary workers, persons engaged includes self-employed proprietors, as reported in the *Census of Business*, all of whom are counted as employed full-time.

The estimates of the number of self-employed may be subject to considerable error because it is difficult to obtain complete coverage of numerous small firms and because the Bureau of the Census definitions of the minimum-sized firm to be included have varied from one census to another. It is some comfort to note that the number of self-employed reported in the *Census of Business* for 1948 corresponds closely to the number reported in the *Census of Population* for 1950 for the eighteen industries.

The importance of obtaining an accurate count of the self-employed is considerable; they account for a significant fraction of total employment in many of the service industries, as may be seen in Table 26. The employment estimates for these industries are probably not as reliable as those that can be obtained for manufacturing or for other industries in which the self-employed play a much less important role.

Doubts may arise concerning the accuracy of the figures on self-employment, but the situation with respect to unpaid family workers is far worse. The *Census of Business* does not regularly report the number

⁴ For a discussion of possible biases in the measurement of real output in retail trade, see Chapter 5.

TABLE 26

Number of Self-Employed as a Percentage of Total Employment
in Eighteen Service Industries, Selected Years, 1939-63

Industry	1939	1948	1954	1958	1963
Services					
Auto repair	48.6	41.3	40.4	34.9	33.1
Barber shops	66.9	61.8	62.3	60.7	61.4
Beauty shops	47.4	47.8	46.6	46.7	44.8
Dry cleaning	37.9	24.4	24.4	23.6	22.1
Hotels and motels	10.4	12.2	12.3	14.1	11.6
Laundries	8.2	10.2	9.2	10.0	12.8
Motion picture theaters	5.8	5.0	6.1	7.7	7.0
Shoe repair	71.9	69.1	68.4	64.8	65.2
Retail trades					
Apparel stores	19.5	15.9	15.8	15.0	13.8
Automobile dealers	11.7	11.2	10.0	10.5	9.0
Drug stores	22.1	17.2	17.0	14.7	12.4
Eating and drinking places	29.3	23.7	23.1	21.0	16.9
Food stores	44.8	38.1	31.6	26.7	21.6
Furniture and appliances	17.7	18.4	21.6	21.5	20.8
Gasoline stations	52.0	44.0	38.9	35.8	31.2
General merchandise	8.8	5.4	5.9	6.2	3.2
Lumber dealers	21.8	16.8	17.4	19.9	16.5
Other	34.8	28.9	34.0	30.5	28.5

Source: U.S. Bureau of the Census, *Census of Business*. Coverage details are in Appendix G.

of such workers, and no attempt has been made in this study to include them in the measure of total employment. Some data for the eighteen service industries reported in the 1948 *Census of Business* indicate that unpaid family workers amounted to about 8 per cent of total employment. The *Census of Population* for 1950, on the other hand, presents figures showing that unpaid family workers accounted for less than 2 per cent of employment in these industries.⁵

⁵ The exclusion of unpaid family workers probably exerts a downward bias on the estimates of the growth of output per man because paid employment probably rose more rapidly than unpaid employment over the period studied. David Schwartzman, in the study of productivity growth in distribution that he is preparing for the National Bureau, estimates that the annual rate of growth of output per man in retailing, 1929-58, would be raised .06 per cent if unpaid family workers were included.

Labor Input

Differentials in rates of change of labor input are estimated from rates of change in labor compensation. The rationale for this approach was described in Chapter 3. Labor compensation for wage and salary workers was calculated from payroll data in the *Census of Business*. Compensation per man for self-employed was estimated using a method similar to that described in Chapter 3.⁶

Output Per Man and Per Unit of Labor Input

Output per man is real output divided by employment; output per unit of labor input is real output divided by labor input. Absolute percentage rates of change for this measure have not been calculated because of the way in which the relative percentage rates of change of labor input are estimated.⁷ Relative values were obtained and used to rank the industries.

Output Per Unit of Total Input

If one is interested only in ranking the industries according to their relative rates of change of output per unit of total input, an estimate can be obtained for the eight services by using the reciprocal of the rates of change of price. The rationale is that, under competitive conditions, rates of change of price of service industries that have very little material input will tend to be inversely correlated with the rates of change

⁶ It is assumed that the same percentage of proprietors' income represents returns to labor for total trade and for total services as in Chapter 3. Within a major industry, it is assumed that the same relative annual earnings of proprietors in each detailed industry prevailed as that shown by the 1/1,000 sample for 1959. Specifically: Compute the 1959 ratio of annual earnings per proprietor of each of the ten retail trades relative to wholesale trade (R). Then multiply the ratios (R) by the number of proprietors (P) in each industry. Obtain a percentage distribution of these products. For the i th year, the share of trade proprietors' labor income going to the j th industry is

$$S_{ij} = \frac{R_j P_{ij}}{\sum_{j=1}^{11} R_j P_{ij}}$$

where $\sum_{j=1}^{11} S_{ij}$ is equal to 90 per cent of the sum of (1) income of unincorporated enterprises and (2) inventory valuation adjustment of unincorporated enterprises from the OBE. For the eight selected services, the ratio is computed relative to "all other services." For those, labor's share of entrepreneurial income is 95 per cent.

⁷ See pp. 49 and 50, Chapter 3.

of productivity. The implicit assumption is that the price of a composite unit of total input changes at the same rate in all industries.

Annual Percentage Rates of Change

The average annual percentage rate of change between 1939 and 1963 and between 1948 and 1963⁸ for each variable was calculated using continuous compounding between the initial and terminal years. The percentage rate of change of a variable, formed by dividing one variable by another (e.g., real output per man), is equal to the percentage rate of change of the numerator minus the percentage rate of change of the denominator.

It should be noted that such trend measures are influenced by the cyclical position of the initial or terminal year. They may also be influenced by random events or errors in the data for one of those years. The question of cyclical effect as opposed to trend is most important for comparisons based on 1939 because the economy had not yet fully recovered from the Depression, and the unemployment rate in that year was 17.2 per cent. The years 1948 and 1963 were characterized by a much higher level of activity than 1939. The unemployment rates for those years were 3.8 and 5.7 per cent, respectively. In an attempt to modify the cyclical effects, rates of change were also derived by fitting regressions across *Census of Business* years including 1954 and 1958, but the rates of change obtained in this way differed very little from those between terminal years.

Empirical Results

Rates of Change, 1939-63

Table 27 presents average percentage rates of change for each of the eighteen service industries. Table 28 gives comparable figures for the aggregates, the total of the eighteen service industries, the manufacturing industry total, the Industry and Service sector totals, and the total economy. These tables are more or less self-explanatory and only a few brief comments need be made.

Perhaps the first and the most important point is that sixteen of the eighteen service industries show positive rates of change of output per man. There may be some upward bias in the rates of change of real output in retail trade (see Chapter 5) but these results suggest caution in

⁸ Analysis over a longer time span is preferable, but the 1948-63 period is included because comparisons between these years are free of the major cyclical element present in the 1939-63 comparison.

TABLE 27
Average Annual Percentage Rates of Changes of Output Per Man and Related Variables,
Eighteen Selected Service Industries, 1939-63 and 1948-63

Industry	1939-63				1948-63			
	Real Output Per Man	Real Output	Employment	Compensation Per Man	Real Output Per Man	Real Output	Employment	Compensation Per Man
Services								
Auto repair	3.5	7.3	3.8	5.8	2.0	5.5	3.5	3.6
Barber shops	.6	.5	-1	6.2	.3	1.3	1.0	3.9
Beauty shops	1.5	4.0	2.5	5.9	1.7	6.7	5.0	3.8
Dry cleaning	2.6	4.5	1.9	5.1	1.7	.9	-8	3.2
Hotels and motels	.9	2.6	1.7	5.6	-5	.8	1.4	3.4
Laundries	1.8	2.6	.9	5.4	.0	.8	.8	2.5
Motion picture theaters	-2.7	-3.1	-4	3.3	-3.2	-6.3	-3.2	2.1
Shoe repair	1.1	-2.2	-3.2	6.1	1.3	-3.0	-4.3	2.9
Retail trades								
Apparel stores	1.0	2.8	1.9	4.4	1.7	2.0	.4	2.4
Automobile dealers	2.2	5.1	2.8	5.7	2.2	3.6	1.4	3.3
Drug stores	2.8	4.8	2.0	5.0	2.3	3.6	1.3	2.9
Eating and drinking places	-2	2.3	2.6	4.9	.2	1.6	1.4	2.2
Food stores	2.4	3.5	1.1	5.7	2.8	3.6	.8	2.8
Furniture and appliances	2.9	5.4	2.4	5.1	3.5	3.4	-1	3.1
Gasoline stations	3.4	5.2	1.8	5.1	2.1	4.9	2.8	2.2
General merchandise	1.5	3.7	2.2	4.6	2.3	3.8	1.4	2.5
Lumber dealers	1.4	3.2	1.8	5.1	1.2	.2	-1.0	3.2
Other	2.2	4.2	1.9	4.9	1.1	2.8	1.6	2.7

Source: Appendix Table G-1.

TABLE 28
Average Annual Percentage Rates of Change of Output Per Man and Related Variables, Industry Groups and Total Economy, 1939-63 and 1948-63

	1939-63				1948-63			
	Real Output Per Man	Real Output	Employment	Compensation Per Man	Real Output Per Man	Real Output	Employment	Compensation Per Man
8 Services, total	1.4	2.9	1.6	5.5	.3	1.6	1.3	3.3
10 Retail trades, total	1.7	3.7	2.0	5.1	1.8	2.9	1.1	2.6
18 Selected service industries, total	1.6	3.6	1.9	5.2	1.5	2.6	1.1	2.8
Manufacturing, total	2.3	4.6	2.3	6.3	2.9	3.5	.6	4.8
Service sector, total	1.8	3.9	2.1	5.8	1.6	3.8	2.2	4.1
Industry sector, total	2.5	4.5	2.0	6.2	3.0	3.3	.4	4.8
Total economy	2.5	4.0	1.6	6.3	2.5	3.4	1.0	4.4

Note: The real output measures used in this table correspond to a portion of the eighteen selected services; the output measure for gross product originating, except for the eight services and their compensation, these is based on deflated gross sales.

Source: Appendix Table G-1.

assuming that productivity cannot or does not increase in service industries. However, Table 28 does show that the rate of increase for the services and the retail trades as a group was not as rapid as for manufacturing, the total Industry sector, or the total economy.

If service industries generally tend to show positive rates of change of output per man, a serious question arises concerning the practice of assuming a zero rate of change for government and other service industries—those for which no convenient method of estimating output, independently of employment, has yet been found. Why not instead assume some constant positive rate of increase, e.g., 1 per cent per annum? It could be argued that such a procedure would be no more arbitrary and perhaps more accurate. Alternatively, one could assume for such industries the same average rate of increase as is found for those service industries for which an independent measure of output is available.⁹

The practice of assuming no differences in output per man for service industries across countries at a given point in time must also be questioned. Is it not likely that some of the same factors that have contributed to increases in output per man in U.S. service industries over time such as increased size of transactions might also be contributing to international differences in output per man at a given time?

Another point to be noted is the tremendous diversity of experience among the eighteen service industries. In five cases, output per man actually grew more rapidly than in the total economy. The range of variation for output and employment was also very great; only compensation per man tended to change at similar rates in the various industries.

Rates of Change, 1948–63

In Tables 27 and 28, output per man in manufacturing shows a higher rate of increase for the 1948–63 period, as do half of the retail trades, but the services all show higher rates for 1939–63. A tentative explanation is that *cyclical* fluctuations in output per man are more important in services, where employment is relatively insensitive to changes in demand and output. (This hypothesis is explored in Chapter 7.) We again observe tremendous diversity among the eighteen industries in rates of growth of all the variables except compensation per man.

Tables 29 and 30 present data for seventeen service industries,¹⁰

⁹ This is the practice followed implicitly in the construction and use of price indexes. If, for instance, we can measure the price change for certain components of medical care but not for others, we do not assume that the unmeasured components had zero price change; we assume that they changed at the same rate as the measured components.

¹⁰ "Other retail trade" is omitted from the rankings because it is a miscellaneous category of questionable significance for economic analyses across industries.

TABLE 29

Rankings of Seventeen Selected Service Industries, Average Annual Percentage Rates of Change of Output Per Man and Related Variables, 1939-63

Industry	Real Output Per Man	Real Output Per Unit of Labor Input	Real Output	Employment	Compen-sation Per Man	Real Output Per Unit of Total Input ^a (8 services only)
Auto repair	17	14	17	17	15	7
Gasoline stations	16	17	15	7	9	—
Furniture and appliances	15	15 ^b	16	15	7	—
Drug stores	14	15 ^b	13	11	5	—
Dry cleaning	13	13	12	10	6	8
Food stores	12	11	9	5	14	—
Automobile dealers	11	9 ^b	14	16	13	—
Laundries	10	8	6	4	10	5
General merchandise	9	12	10	12	3	—
Beauty shops	8	6	11	14	11	6
Lumber dealers	7	7	8	8	8	—
Shoe repair	6	4	2	1	16	2
Apparel stores	5	9 ^b	7	9	2	—
Hotels and motels	4	5	5	6	12	3 ^b
Barber shops	3	2	3	3	17	1
Eating and drinking places	2	3	4	15	4	—
Motion picture theaters	1	1	1	2	1	3 ^b

Note: Highest value of each variable is given the highest rank. Rankings were computed from the more detailed data underlying Table 27.

^a Based on the reciprocal of the price index.

^b Rankings of these industries are halfway between the figures shown and the next highest figure.

Source: Table 27 and Appendix Table G-1.

TABLE 30

Rankings of Seventeen Selected Service Industries, Average Annual Percentage Rates of Change of Output Per Man and Related Variables, 1948-63

Industry	Real Output Per Man	Real Output Per Unit of Labor Input	Employment	Compen-sation Per Man	Real Output Per Unit of Total Input ^a (8 services only)
Furniture and appliances	17	14	5	10	-
Food stores	16	17	7	7	-
General merchandise	15	15	14	5	-
Drug stores	14	13	10	9	-
Automobile dealers	13	11	13	13	-
Gasoline stations	12	16	15	3	-
Auto repair	11	8	16	15	5
Dry cleaning	10	10	4	12	8
Beauty shops	9	5	17	16	7
Apparel stores	8	12	6	4	-
Shoe repair	7	9	1	8	6
Lumber dealers	6	6	3	11	-
Barber shops	5	3	9	17	1
Eating and drinking places	4	7	12	2	-
Laundries	3	4	8	6	4
Hotels and motels	2	2	11	14	2
Motion picture theaters	1	1	2	1	3

Note: Rankings were computed from the more detailed data underlying Table 29.

^a Based on the reciprocal of the price index.

^b Rankings of these industries are halfway between the figures shown and the next highest figure.

Source: Table 28 and Appendix Table G-1.

ranked according to the various measures of output, input, and productivity. Table 31 shows the correlations between the rankings for 1939-63 and 1948-63. Most of these correlations are significantly different from zero; this is not surprising since there is a great deal of overlap between these two periods. The correlations are sufficiently below 1.00, however, to indicate that the inclusion or exclusion of 1939 can make a substantial difference, especially for the retail trades.

Relation Between Changes in Output Per Man and Other Variables

Given the substantial variation among service industries in rates of change of output per man, it is of interest to see whether the same pattern of variation can be found in some of the other variables, i.e., whether rates of change are correlated across industries.

The relation between industry rates of growth and output per man is of particular interest. Many previous studies have found a significant positive correlation between these two variables. However, these studies were mostly confined to or dominated by manufacturing industries. When

TABLE 31

Coefficients of Rank Correlation Between Average Annual Percentage Rates of Change of Output Per Man and Related Variables, Selected Service Industries, 1939-63 and 1948-63

	Seventeen Selected Service Industries	Eight Services	Nine Retail Trades
Real output per man	.76	.81	.65
Real output per unit of labor input	.78	.64	.76
Real output	.75	.75	.62
Employment	.62	.81	.17
Compensation per man	.66	.64	.45
Real output per unit of total input	n.a.	.71	n.a.

Note: Minimum values of rank correlation coefficients for various levels of statistical significance (two-tailed test):

α	$N = 8$	$N = 9$	$N = 10$	$N = 25$
.10	.64	.58	.56	.34
.05	.73	.68	.65	.40
.01	.86	.82	.79	.53

Source: Tables 29 and 30.

TABLE 32

Coefficients of Rank Correlation, Average Annual Percentage Rates of Change of Output Per Man and Related Variables,
Across Selected Service Industries, 1939-63

	Real Output Per Unit of Labor Input	Real Output	Employment	Compen- sation Per Man	Real Output Per Unit of Total Input
Real output per man					
17 service industries	.93	.91	.42	.17	n.a.
8 services	.98	.90	.71	-.05	.81
9 retail trades	.91	.90	-.27	.52	n.a.
Real output per unit of labor input					
17 service industries		.89	.44	-.11	n.a.
8 services		.95	.81	-.10	.85
9 retail trades		.81	-.28	.15	n.a.
Real output					
17 service industries			.70	.05	n.a.
8 services			.93	-.05	.85
9 retail trades			.10	.42	n.a.
Employment					
17 service industries				-.15	n.a.
8 services				-.10	.80
9 retail trades				-.28	n.a.
Compensation per man					
17 service industries					n.a.
8 services					-.53
9 retail trades					n.a.

Source: Table 29.

TABLE 33

Coefficients of Rank Correlation, Average Annual Percentage Rates of Change of: Output Per Man and Related Variables, Across Selected Service Industries, 1948-63

	Real Output Per Unit of Labor Input	Real Output	Employment	Compen- sation Per Man	Real Output Per Unit of Total Input
Real output per man					
17 service industries	.89	.69	.25	.08	n.a.
8 services	.86	.71	.33	.48	.69
9 retail trades	.72	.48	-.02	.35	n.a.
Real output per unit of labor input					
17 service industries		.55	.13	-.27	n.a.
8 services		.34	-.10	.12	.83
9 retail trades		.73	.37	-.25	n.a.
Real output					
17 service industries			.83	.21	n.a.
8 services			.84	.85	.26
9 retail trades			.80	-.08	n.a.
Employment					
17 service industries				.25	n.a.
8 services				.74	-.05
9 retail trades				-.42	n.a.
Compensation per man					
17 service industries					n.a.
8 services					-.10
9 retail trades					n.a.

Source: Table 30.

TABLE 34

Summary of Coefficients of Rank Correlation Between Rates of Change of Output Per Man and Output and Employment, Across Industries

	Output Per Man and	
	Output	Employment
1. U.S., 1939-63-17 service industries	.91	.42
2. U.S., 1948-63-17 service industries	.69	.25
3. U.S., 1899-1937-56 manufacturing industries	.73	.31
4. U.S., 1899-1953-33 industry groups	.64 ^a	.33 ^a
5. U.S., 1899-1954-80 manufacturing industries	.67 ^b	.33 ^c
6. U.K., 1924-50-28 manufacturing industries	.83	.57
7. U.K., 1954-63-28 manufacturing industries	.69	.04
8. U.S., 1929-65-10 major industry groups	-.18	-.88

Source: 1, Table 32; 2, Table 33; 3, Fabricant, *Employment in Manufacturing*; 4 and 5, Kendrick, *Productivity Trends in the U.S.*; 6, Salter, *Productivity and Technical Change*; 7, *ibid.*, second edition; 8, Fuchs, *Productivity Trends*.

^a Based on output per unit of total factor input.

^b Based on output per adjusted man-hour.

^c Based on output per man-hour.

this relationship was tested across ten major industry groups in the United States, no correlation between growth and productivity could be observed.¹¹ In this chapter the hypothesis is tested across the seventeen service industries.

Tables 32 and 33 show the coefficients of rank correlation for every combination of variables. Correlations between rates of change of output per man ($\dot{O}-\dot{E}$) and output (\dot{O}) and employment (\dot{E}) are considered first. Either output or employment can be used to measure industry rates of growth; therefore, we must look at both sets of correlations. The correlation with output tends to be biased upward, and the reverse is true of employment.¹²

The coefficients shown in Tables 32 and 33 tend to support the hypothesis of a positive correlation between growth and productivity. Table 34 indicates that the relationship found among the seventeen service

¹¹ See Chapter 3.

¹² Whenever a correlation coefficient is calculated between one variable and another which is based in part on the first, the danger of spurious correlation arises. For the correlations described above, to the extent that there are errors in the observations, these errors alone would tend to produce a positive correlation for ($\dot{O}-\dot{E}$): \dot{O} , and a negative correlation for ($\dot{O}-\dot{E}$): \dot{E} .

industries is of the same order of magnitude as that found by other investigators for manufacturing industries.

One way of circumventing the problem of spurious correlation between output per man and output, or between output per man and employment, is to fit by least-squares two equations relating changes in output and changes in employment (see Charts 7 and 8). In one equation, output is the dependent variable; in the other equation, the relationship is reversed. If there is no correlation between industry rates of growth (measured by output or employment) and industry rates of change of output per man, the slope of the regression line between output and employment should equal unity. Regression lines with slopes greater than unity indicate a positive correlation. Slopes smaller than unity indicate a negative relationship.¹³

The regression lines for Charts 7 and 8 are as follows:

1939-63

$$\dot{O} = .914 + 1.433\dot{E} \quad \bar{R}^2 = .727$$

(.217)

$$\dot{E} = -.088 + .519\dot{O}$$

(.079)

1948-63

$$\dot{O} = 1.095 + 1.253\dot{E} \quad \bar{R}^2 = .776$$

(.167)

$$\dot{E} = -.546 + .631\dot{O}$$

(.084)

The slopes of the lines on the charts when employment is dependent are the reciprocals of the regression coefficients. In all cases the slope of the regression line is considerably above unity. These results, however, depend primarily on the relationship among the services; the retail trades alone yield an ambiguous result.

Both the rank correlations and the regression slopes indicate that the relation between growth and productivity was stronger for 1939-63 than for 1948-63. This probably reflects a cyclical relation between growth and productivity in addition to the secular one.

The finding of a positive relation between industry rates of growth and changes in productivity raises an interesting question about productivity trends in those service industries not included in this chapter.¹⁴

¹³ See Fabricant, *Employment in Manufacturing*, p. 87.

¹⁴ I am grateful to Edward F. Denison for calling this question to my attention.

CHART 7

Relation Between Average Annual Percentage Rates of Change of Real Output and Employment, Seventeen Selected Service Industries, 1939-63

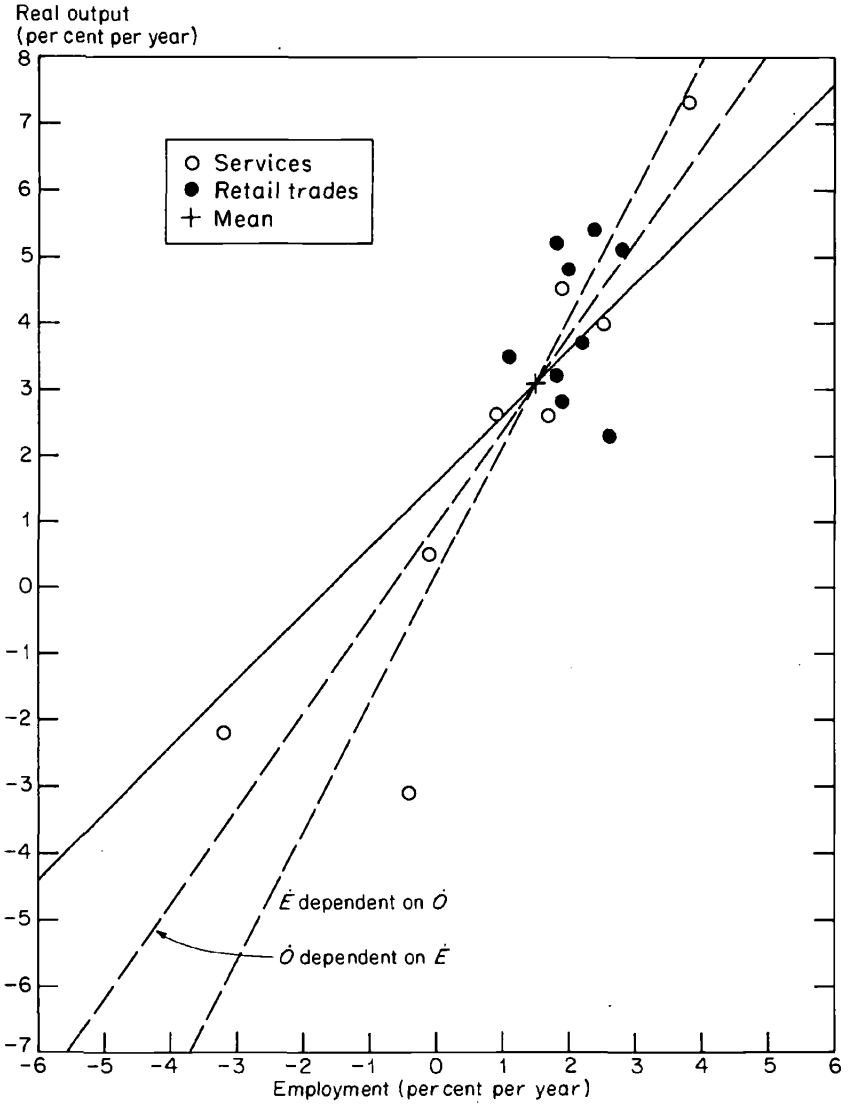
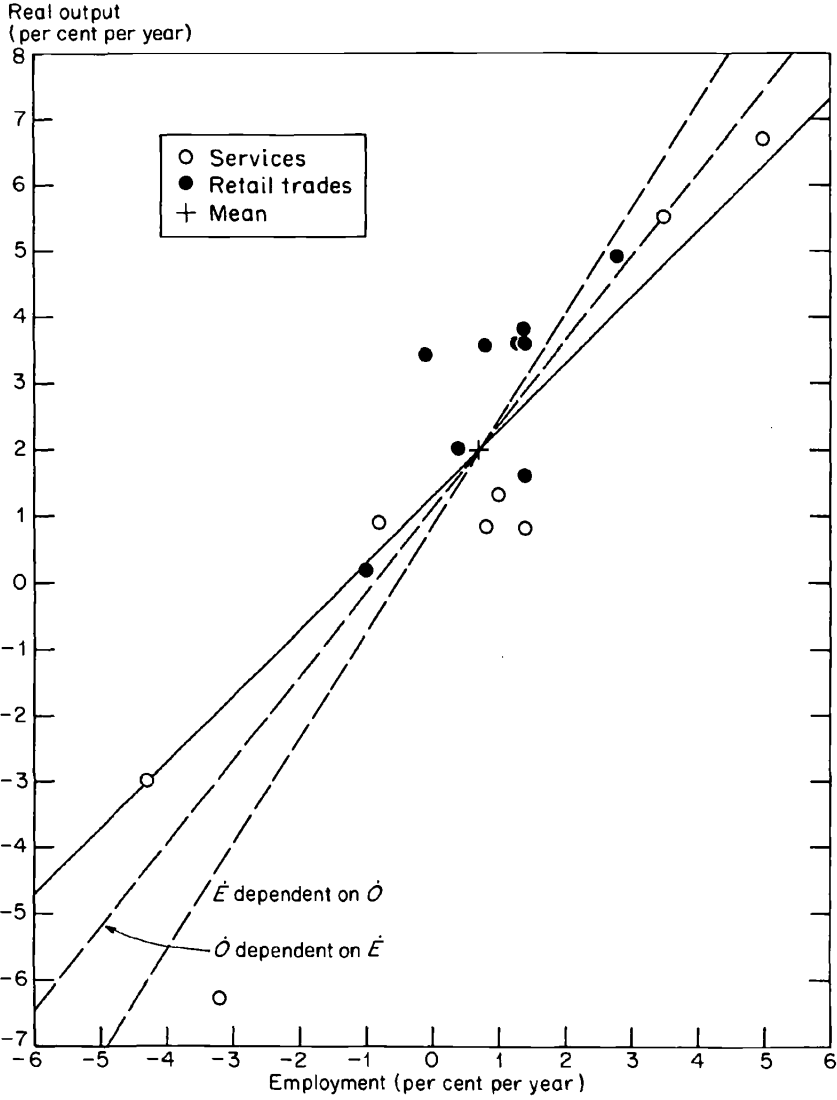


CHART 8

Relation Between Average Annual Percentage Rates of Change of Real Output and Employment, Seventeen Selected Service Industries, 1948-63



As can be seen in Table 35, the excluded industries had, on average, much faster rates of growth of employment than did the seventeen included industries. If we were to assume that the relationships shown in Charts 7 and 8 between growth of output and growth of employment extended to the excluded industries, we would have to conclude that output per man in those industries grew much more rapidly than in the seventeen industries covered in the present study. Present measures of real gross product originating do not yield that conclusion, but the assumptions underlying those measures are the subject of considerable

TABLE 35

Annual Rates of Change of Employment: Comparison of Twenty Excluded Service Industries with Seventeen Selected Service Industries, 1939-63 (per cent per annum)

Industry	1939-63	1948-63
Federal general government, military	8.64	4.12
Miscellaneous professional services	7.84	4.80
Miscellaneous business services	5.08	6.24
Nonprofit membership organizations	5.05	3.54
Federal general government, civilian	4.92	1.62
Educational services	4.29	4.50
Medical and other health services	4.22	4.55
Credit agencies, holding and other investment companies	4.10	5.96
Banking	3.80	3.79
State and local, public education	3.57	4.73
Insurance carriers	2.84	2.72
State and local general government, nonschool except work relief	2.80	3.29
Amusement and recreation services except motion pictures	2.58	2.19
Miscellaneous repair services	2.23	.84
Wholesale trade	2.05	1.18
Security and commodity brokers	1.95	4.46
Real estate	1.66	.89
Insurance agents, brokers and services	1.59	3.49
Legal services	1.25	2.73
Private households	-1.26	-1.18
Median of 20 excluded industries	3.20	3.52
Median of 17 selected services	1.86	1.00

Source: U.S. Office of Business Economics, *The National Income and Product Accounts of the United States, 1929-1965*, Table 6-6.

TABLE 36

Coefficients of Rank Correlation Between Change in Self-Employment as Percentage of Total Employment and Rate of Change of Output Per Man, Output, and Employment, 1939-63

		1939-63	1948-63
$\Delta S: \bar{O}-\bar{E}$	17 service industries	-.44	-.41
	8 services	-.48	-.79
	9 retail trades	-.10	.03
$\Delta S: \bar{O}$	17 service industries	-.33	-.56
	8 services	-.44	-.44
	9 retail trades	.30	-.46
$\Delta S: \bar{E}$	17 service industries	-.15	-.44
	8 services	-.30	-.26
	9 retail trades	-.63	-.59

Note: ΔS = Percentage self-employed in terminal year minus percentage self-employed in initial year. \bar{Q} , \bar{E} , $\bar{O}-\bar{E}$ = Average annual percentage rate of change of real output, employment, and real output per man, respectively.

Source: Tables 26, 29, and 30.

debate. However, no widely acceptable alternative measures of real output for the excluded industries are available.

The results shown in Tables 32 and 33 parallel those reported for manufacturing in one other respect, namely, the absence of any correlation between changes in output per man and changes in compensation per man. This result would appear to refute the hypothesis that differential changes in the quality of labor can make a significant contribution to the explanation of differential changes in output per man in these industries. On the other hand, there have been very large differences in rates of change of compensation per man between the service industries and manufacturing.

One other set of correlations was run to test the relation between changes in output per man and changes in the percentage of employment accounted for by self-employed. It has been argued that large numbers of the self-employed are not very active and have very low productivity.¹⁵

¹⁵ Edward F. Denison, "Improved Allocation of Labor as a Source of Higher European Growth Rates," in Michael J. Brennan, ed., *Patterns of Market Behavior*, Providence, 1965.

Their alternative to self-employment may be unemployment. One would expect, therefore, that industries which showed a large absolute decline in the percentage of employment accounted for by self-employed might show large increases in output per man. The coefficients of rank correlation shown in Table 36 provide some slight support for this hypothesis, particularly with respect to the eight services. The same table also shows the correlations between changes in the self-employment percentage and the percentage rates of change of output and employment. There is apparently some intercorrelation among all these variables, and much more work needs to be done before any conclusions concerning causality would be warranted.¹⁶

This brief statistical analysis of changes in productivity and other variables within the Service sector tends to support conclusions based on studies of manufacturing industries. In appraising these results, it is well to recall that the measures of real output and productivity can be considered only as approximations. Additional insights into some of the conceptual and statistical problems require more intensive scrutiny of particular industries.

The three case studies to be discussed in the next chapter are intended to probe more deeply into the relation between growth, technological change, labor quality, etc., in order to increase our understanding of the process of productivity change.

¹⁶ See Irving F. Leveson, "Nonfarm Self-employment in the U.S.," unpublished Ph.D. dissertation, Columbia University, January, 1968.