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## EMPIRICAL RESULTS

## RATES OF CHANGE, 1939-63

TABLE I-4 presents average percentage rates of change for each of the eighteen service industries. Table I-5 gives comparable figures for the aggregates and permits comparison with manufacturing, the total goods and service sectors, 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 industries show positive rates of change of output per man. Unless the real output rates of change are systematically and markedly biased upward, there appears to be no basis for assuming that productivity cannot or does not increase in service industries. However, Table I-5 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 goods 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 for which no convenient method of estimating output, independently of employment, has yet been found. Why not assume some constant, positive rate of increase, e.g., 1 per cent per annum, instead? 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.

In a similar vein, the practice of assuming no differences in output per man for service industries across countries at a given point in time

TABLE I-4

*Average Annual Percentage Rates of Change, Output per Man and Related Variables, 18 Selected Service Industries, 1939-63*

Industry	Real Output per Man	Real Output	Employment	Compensation per Man
<u>Services</u>				
Auto repair	3.32	7.14	3.82	5.06
Barber shops	.60	.60	.00	5.67
Beauty shops	1.69	4.08	2.39	5.37
Dry cleaning	2.47	4.41	1.94	4.75
Hotels and motels	.49	2.20	1.71	5.35
Laundries	1.42	2.36	.94	4.78
Motion picture theaters	-2.83	-3.28	-.45	2.98
Shoe repair	1.16	-2.07	-3.23	4.77
<u>Retail trades</u>				
Apparel stores	.99	2.86	1.87	4.17
Automobile dealers	2.09	4.82	2.73	5.19
Drug stores	2.68	4.71	2.03	5.29
Eating and drinking places	-.18	2.30	2.48	5.31
Food stores	2.44	3.62	1.18	5.32
Furniture and appliances	2.88	5.37	2.49	4.88
Gasoline stations	3.25	5.25	2.00	5.08
General merchandise	1.40	3.53	2.13	4.38
Lumber dealers	1.21	3.07	1.86	4.99
Other	2.09	4.11	2.02	4.63

Source: Appendix B.

TABLE I-5

*Average Annual Percentage Rates of Change, Output per Man and Related Variables, Industry Groups and Total Economy, 1939-63*

	Real Output per Man	Real Output	Employ- ment	Compen- sation per Man
8 Services, total	1.14	2.68	1.54	5.07
10 Retail trades, total	1.63	3.67	2.04	4.90
18 Selected service industries, total	1.52	3.45	1.93	4.96
Manufacturing, total	2.26	4.22	1.96	6.32
Service sector, total	1.45	3.75	2.30	5.62
Goods sector, total	3.03	3.94	.91	6.83
Total economy	2.23	3.84	1.61	6.22

Source: Appendix B.

must be questioned. Is it not likely that some of the same factors that have contributed to increases in output per man in service industries in the United States over time might also be contributing to international differences in output per man at a given time?

A second point to be noted is the tremendous diversity of experience among the eighteen service industries. In one-third of the 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

Tables I-6 and I-7 present the rates of change for the 1948-63 period. Output per man in manufacturing shows a higher rate of increase for this 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

TABLE I-6

*Average Annual Percentage Rates of Change, Output per Man and Related Variables, 18 Selected Service Industries, 1948-63*

Industry	Real Output per Man	Real Output	Employ- ment	Compen- sation per Man
<u>Services</u>				
Auto repair	1.85	5.78	3.93	3.27
Barber shops	.19	1.48	1.29	3.48
Beauty shops	1.54	6.76	5.22	3.34
Dry cleaning	1.65	.90	-.75	3.02
Hotels and motels	-.68	.86	1.54	3.19
Laundries	-.03	.86	.89	2.16
Motion picture theaters	-3.40	-6.46	-3.06	1.93
Shoe repair	1.16	-2.84	-4.00	3.03
<u>Retail trades</u>				
Apparel stores	1.62	2.06	.44	2.81
Automobile dealers	1.91	3.28	1.37	3.57
Drug stores	2.15	3.58	1.43	4.19
Eating and drinking places	.12	1.63	1.51	2.80
Food stores	2.75	3.58	.83	3.08
Furniture and appliances	3.38	3.40	.02	3.51
Gasoline stations	1.92	4.95	3.03	3.27
General merchandise	2.32	3.80	1.48	2.68
Lumber dealers	1.09	.18	-.91	3.59
Other	1.00	2.78	1.78	3.21

Source: Appendix B.

TABLE I-7

*Average Annual Percentage Rates of Change, Output per Man and Related Variables, Industry Groups and Total Economy, 1948-63*

	Real Output per Man	Real Output	Employ- ment	Compen- sation per Man
8 Services, total	.21	1.66	1.45	3.08
10 Retail trades, total	1.72	2.93	1.21	3.05
18 Selected service industries, total	1.41	2.65	1.24	3.07
Manufacturing, total	2.60	3.04	.44	4.86
Service sector, total	1.23	3.52	2.29	4.25
Goods sector, total	3.07	2.96	-.11	4.92
Total economy	2.14	3.23	1.09	4.54

Source: Appendix B.

employment is relatively insensitive to changes in demand and output.<sup>6</sup> We again observe tremendous diversity among the eighteen industries in rates of growth of all the variables except compensation per man.

Tables I-8 and I-9 present seventeen service industries,<sup>7</sup> ranked according to the various measures of output, input, and productivity. Table I-10 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 considering the fact that 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.

<sup>6</sup> See Victor R. Fuchs, *The Growing Importance of the Service Industries*, Occasional Paper 96, New York, National Bureau of Economic Research, 1965, pp. 45-51.

<sup>7</sup> "Other retail trade" is omitted from the rankings because it is a miscellaneous category of questionable significance for economic analyses across industries.

INTERINDUSTRY DIFFERENCES IN RATES OF  
CHANGE OF OUTPUT PER MAN

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 relationship 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.<sup>8</sup> The explanation of the relationship usually runs in two opposite directions—from productivity change to industry growth, and from industry growth to productivity. The first argument is that rapid productivity growth leads to lower prices which stimulate demand and output. The alternative argument is that changes in income or taste that increase demand and output permit economies of scale and other efficiencies which show up as higher productivity.

These previous studies have mostly been confined to or dominated by manufacturing industries. When this relationship was tested across ten major industry groups in the United States, no correlation between growth and productivity could be observed.<sup>9</sup> In this paper the hypothesis is tested across the seventeen service industries.

Tables I-11 and I-12 show the coefficients of rank correlation for every combination of variables. Correlations between output per man ( $O/E$ ) and output ( $O$ ) and employment ( $E$ ) are the ones to be 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.<sup>10</sup>

The coefficients shown in Tables I-11 and I-12 tend to support the

<sup>8</sup> See, for example, Solomon Fabricant, *Employment in Manufacturing, 1899-1939*, New York, NBER, 1942, pp. 88, 146; John W. Kendrick, *Productivity Trends in the United States*, Princeton University Press for NBER, 1961, pp. 207-216; W. E. G. Salter, *Productivity and Technical Change*, Cambridge, Eng., 1960, p. 123.

<sup>9</sup> Fuchs, *Productivity Trends*, p. 17.

<sup>10</sup> 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. To the extent that there are errors in the observations, these errors alone would tend to produce a positive or negative correlation, depending upon the position of the variable in numerator or denominator on both sides of the equation.

TABLE I-8

*Rankings of 17 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	Compensation per Man	Real Output per Unit of Total Input <sup>a</sup> (8 services only)
Auto repair	17	17	17	17	9	7
Gasoline stations	16	16	15	10	10	
Furniture and appliances	15	15	16	15	7	
Drug stores	14	13	13	11	12	
Dry cleaning	13	14	12	9	4	8
Food stores	12	12	10	5	14	
Automobile dealers	11	10	14	16	11	
Beauty shops	10	6	11	13	16	6
Laundries	9	8	6	4	6	5
General merchandise	8	11	9	12	3	
Lumber dealers	7	5	8	7	8	
Shoe repair	6	7	2	1	5	3
Apparel stores	5	9	7	8	2	
Barber shops	4	3	3	3	17	1
Hotels and motels	3	4	4	6	15	2
Eating and drinking places	2	2	5	14	13	
Motion picture theaters	1	1	1	2	1	4

Source: Table 4 and Appendix B.

<sup>a</sup>Based on the reciprocal of the rate of change of price.



TABLE I-9

Rankings of 17 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	Real Output	Employment	Compensation per Man	Real Output per Unit of Total Input <sup>a</sup> (8 services only)
Furniture and appliances	17	17	11	5	14	
Food stores	16	16	12.5	7	8	
General merchandise	15	15	14	12	3	
Drug stores	14	7	12.5	11	17	
Gasoline stations	13	13	15	15	10.5	
Automobile dealers	12	10	10	10	15	5
Auto repair	11	11	16	16	10.5	8
Dry cleaning	10	12	6	4	6	
Apparel stores	9	14	9	6	5	7
Beauty shops	8	9	17	17	12	6
Shoe repair	7	8	2	1	7	
Lumber dealers	6	5	3	3	16	1
Barber shops	5	3	7	9	13	
Eating and drinking places	4	4	8	13	4	4
Laundries	3	6	4.5	8	2	
Hotels and motels	2	2	4.5	14	9	2
Motion picture theaters	1	1	1	2	1	3

Source: Table 6 and Appendix B.

<sup>a</sup>Based on the reciprocal of the change of price.

TABLE I-10  
*Coefficients of Rank Correlation Between Average Annual  
 Percentage Rates of Change, 1939-63 and 1948-63, of  
 Output per Man and Related Variables,  
 Selected Service Industries*

	17 Selected Service Industries	8 Services	9 Retail Trades
Real output per man	.77	.93	.72
Real output per unit of labor input	.79	.86	.58
Real output	.75	.76	.58
Employment	.58	.81	.25
Compensation per man	.58	.90	.20
Real output per unit of total input	n.a.	.81	n.a.

Source: Tables 8 and 9.

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

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

hypothesis of a positive correlation between growth and productivity. Table I-13 indicates that the relationship found among the seventeen service 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 least-squares regression lines directly to two equations relating changes in output and changes in employment. In one equation, output is treated as dependent upon employment; 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.<sup>11</sup>

The regression lines for Charts I-1 and I-2 are as follows:

1939-63

$$O = .813 + 1.435E \quad \bar{R}^2 = .727$$

(.469) (.217)

$$E = -.032 + .519O$$

(.309) (.078)

1948-63

$$O = .944 + 1.245E \quad \bar{R}^2 = .768$$

(.396) (.169)

$$E = -.411 + .629O$$

(.313) (.086)

The slopes of the lines on the charts when employment is dependent are the reciprocals of the regression coefficients.

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 pro-

<sup>11</sup> Cf. Fabricant, *Employment in Manufacturing*, p. 87.

TABLE I-11

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

	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
Real output per man	(1)	.94	.93	.54	.06	
	(2)	.90	.90	.74	.07	.81
	(3)	.97	.93	.07	.12	
Real output per unit of labor input	(1)		.87	.50	-.15	.74
	(2)		.81	.57	-.14	
	(3)		.87	.03	.00	
Real output	(1)			.79	.10	
	(2)			.93	.21	.76
	(3)			.33	.02	
Employment	(1)				.10	
	(2)				.33	.67
	(3)				-.06	
Compensation per man	(1)					
	(2)					
	(3)					-.38

Source: Table 8.

(1) Across 17 selected service industries.

(2) Across 8 services.

(3) Across 9 retail trades.

TABLE I-12

*Coefficients of Rank Correlation, Average Annual Percentage Rates of Change (1948-63) of Output per Man and Related Variables, Across Selected Service Industries*

	Real Output per Man	Real Output per Unit of Labor Input	Real Output	Employment	Compensation per Man	Real Output per Unit of Total Input
Real output per man	(1)	.88	.70	.13	.88	
	(2)	.95	.71	.33	.43	.69
	(3)	.85	.69	-.10	.04	
Real output per unit of labor input	(1)		.71	.03	.07	
	(2)		.60	.21	.21	.83
	(3)		.51	-.25	-.26	
Real output	(1)			.73	.31	
	(2)			.84	.78	.26
	(3)			.55	-.13	
Employment	(1)				.18	
	(2)				.69	-.05
	(3)				-.38	
Compensation per man	(1)					
	(2)					
	(3)					-.14

Source: Table 9.

(1) Across 17 selected service industries.

(2) Across 8 services.

(3) Across 9 retail trades.

TABLE I-13

*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	.93	.54
2. U.S. 1948-63-17 service industries	.70	.13
3. U.S. 1899-1937-56 manufacturing industries	.73	.31
4. U.S. 1899-1953-33 industry groups	.64 <sup>a</sup>	.33 <sup>a</sup>
5. U.S. 1899-1954-80 manufacturing industries	.67 <sup>b</sup>	.33 <sup>c</sup>
6. U.K. 1924-50-28 manufacturing industries	.83	.57
7. U.S. 1929-61-10 major industry groups	-.01	-.84

Source by Columns: 1, Table 11; 2, Table 12; 3, Fabricant, *Employment in Manufacturing*; 4 and 5, Kendrick, *Productivity Trends in the U.S.*; 6, Salter, *Productivity and Technical Change*; 7, Fuchs, *Productivity Trends*.

<sup>a</sup>Based on output per unit of total factor input.

<sup>b</sup>Based on output per adjusted man-hour.

<sup>c</sup>Based on output per man-hour.

ductivity trends in those service industries not included in the present study.<sup>12</sup> As can be seen in Table I-14, 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 I-1 and I-2 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 national product do not yield that conclusion, but they are based for the most part on arbitrary assumptions about real output, including the assumption that labor productivity never changes. No widely acceptable alternative measure of real output for the excluded industries is available.

<sup>12</sup> I am grateful to Edward F. Denison for calling this question to my attention.

The results shown in Tables I-11 and I-12 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. This indicates that a differential change in labor quality may explain part of the differential change in output per man between manufacturing and the service industries.

One other set of correlations that was run tests 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 really very active and have very low productivity.<sup>13</sup> 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 I-15 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 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.

This brief look at some individual service industries suggests that a much more intensive examination of a few industries might produce very interesting results. The statistical analysis presented in this paper has resulted in some tentative conclusions concerning the relation between productivity, growth, labor quality, and other variables. Through an intensive case study, it might be possible to discover just how these interrelations develop in specific industries and to obtain

<sup>13</sup> 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.

CHART I-1

*Relation Between Average Annual Percentage Rates of Change of Real Output and Employment, 17 Selected Service Industries, 1939-63*

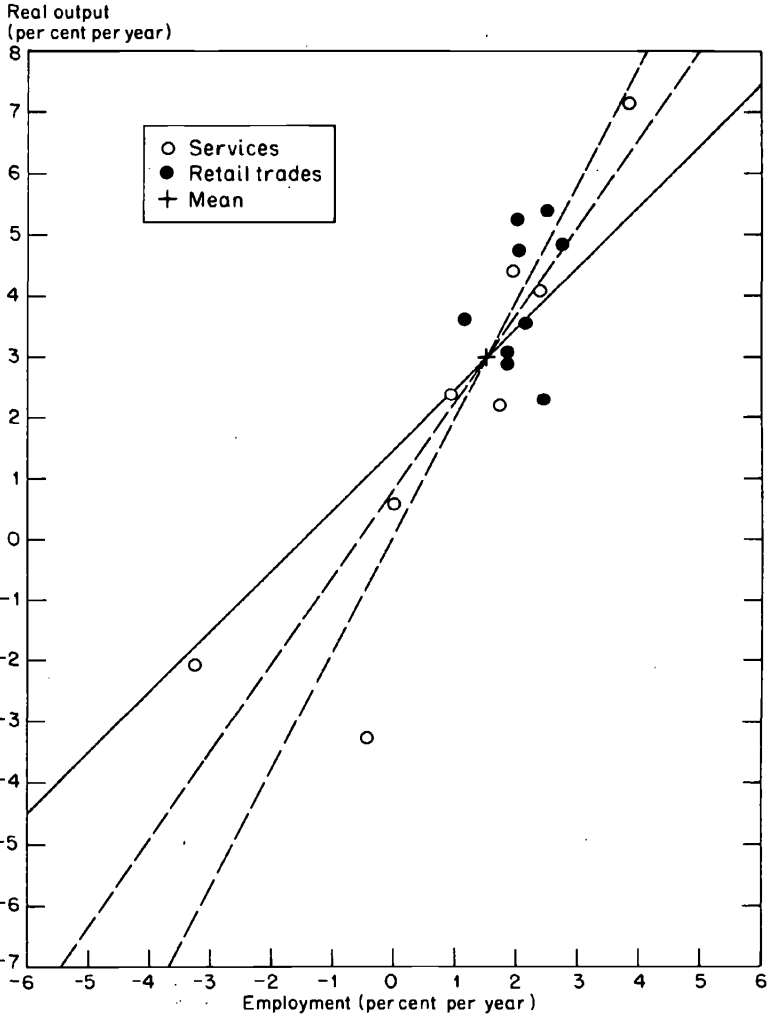




CHART I-2

*Relation Between Average Annual Percentage Rates of Change of Real Output and Employment, 17 Selected Service Industries, 1948-63*

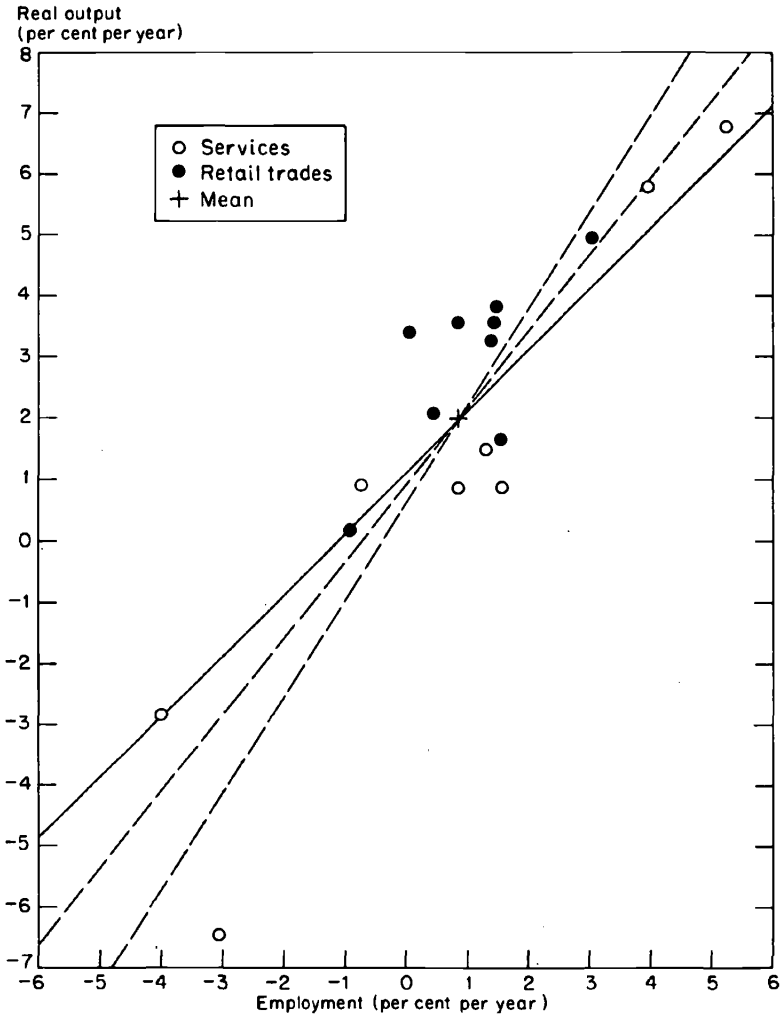


TABLE I-14

*Comparison of Annual Rates of Change of Employment of 21 Excluded Service Industries with 17 Selected Service Industries, 1939-63*  
(per cent per annum)

Industry	1939-63	1948-63
Federal general government, military	8.64	4.12
Engineering and other professional services, n.e.c.	6.20	5.78
Business services, n.e.c.	5.77	5.79
Federal general government, civilian	4.80	1.56
Finance, n.e.c.	4.66	6.78
Commercial and trade schools and employment agencies	4.51	2.76
Nonprofit membership organizations, n.e.c.	4.20	3.22
Medical and other health services	4.17	4.48
Banking	3.84	3.84
Educational services, n.e.c.	3.60	3.89
State and local general government, public education	3.57	4.74
Insurance carriers	3.22	3.30
Insurance agents and combination offices	2.99	3.51
Miscellaneous repair services and hand trades	2.87	1.14
State and local general government, nonschool except work relief	2.83	3.34
Wholesale trade	2.32	1.49
Amusement and recreation except motion pictures	2.13	1.46
Security and commodity brokers, dealers, and exchanges	1.95	4.67
Real estate	1.81	1.90
Legal services	1.06	2.42
Private households	-1.27	-.18
Median of 21 excluded industries	3.57	3.34
Median of 17 selected services	1.87	1.29

Source: U.S. Office of Business Economics, *Survey of Current Business*, July 1964, Table VI-16; *U.S. Income and Output*, Table VI-16; *National Income, 1954 edition*, Table 28.

Note: For excluded industries, rates of change were computed between terminal years.

TABLE I-15

*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	1948-63
$\Delta S : O/E$	17 service industries	-.36	-.45
	8 services	-.60	-.78
	9 retail trades	-.05	-.04
$\Delta S : O$	17 service industries	-.29	-.12
	8 services	-.43	-.29
	9 retail trades	.25	.57
$\Delta S : E$	17 service industries	-.57	-.43
	8 services	-.43	-.26
	9 retail trades	-.40	-.63

Source: Tables 3, 8, and 9.

Note:  $\Delta S$  = Percentage self-employed in initial year minus percentage self-employed in terminal year.  $O$ ,  $E$ ,  $O/E$  = Average annual percentage rate of change of real output, employment, and real output per man.

an understanding of the process of productivity change at the level of the producing unit. Jean Wilburn's study (Part II) uses the contrast between the barber and beauty shop industries as a point of departure, and develops in detail answers to many of the questions that have been raised in this study.