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# 5

# INDUSTRY PATTERNS OF PRODUCTIVITY CHANGE

The degree of dispersion among industries in the rates of change in real product and productivity has been quite similar in the post-1948 period to that prevailing in earlier periods. The variability in subperiod and annual rates of change in industry measures, however, has been less than before 1948, reflecting a steadier rate of economic growth. The degrees of dispersion and variability are greater, of course, the greater the amount of industry detail used in the analysis.

This chapter is essentially descriptive, providing a summary review of the post-1948 record of productivity changes in major industry segments and groups. Total factor productivity and output per unit of tangible capital input measures are available for study of seven segments and thirty-two two-digit industry groups. Real product and labor productivity measures are available for all nine one-digit segments and forty industry groups. In addition, we have supplementary measures of output per man-hour for 395 four-digit manufacturing industries for the 1954-63 period.

While of some interest in their own right, the industry productivity index numbers are of particular value for analyzing changes in industry structure and the causal forces behind productivity advance. The analysis of relationships between productivity changes and associated variables is presented in the following chapter; readers who are in a hurry can skip the verbal description in this chapter and, after looking at the summary tables and charts below, turn to Chapter 6.

## Total Factor Productivity

Compound percentage rates of change in total factor productivity over the period 1948-66 differed considerably among the major industry segments.

TABLE 5-1

Private Domestic Business Economy: Total Factor Productivity, by Industry Segment and Group, Average Annual Percentage Rates of Change

| | 1948-66 | 1948-53 | 1953-57 | 1957-60 | 1960-66 | Average Deviation |
|---|---|---|---|---|---|---|
| Private domestic business economy | 2.5 | 2.8 | 1.9 | 2.3 | 2.9 | 0.4 |
| Farming | 3.3 | 3.7 | 2.5 | 4.4 | 3.1 | 0.5 |
| Mining | 4.2 | 5.1 | 3.4 | 3.6 | 4.2 | 0.5 |
| Metal | 2.4 | 1.4 | 1.5 | 0.9 | 4.6 | 1.2 |
| Coal | 5.2 | 3.5 | 6.9 | 4.8 | 5.7 | 1.1 |
| Oil and gas | 3.2 | 2.7 | 1.8 | 2.7 | 4.9 | 1.1 |
| Nonmetal | 2.6 | 2.4 | 3.6 | 4.5 | 1.3 | 1.0 |
| Contract construction | 1.5 | 3.6 | 2.8 | 1.1 | −1.0 | 1.8 |
| Manufacturing | 2.5 | 2.9 | 1.5 | 2.0 | 3.2 | 0.6 |
| Nondurables | 2.6 | 2.5 | 2.6 | 2.4 | 2.8 | 0.1 |
| Foods | 3.0 | 2.2 | 4.0 | 4.0 | 2.6 | 0.7 |
| Beverages | 2.2 | 0.1 | 4.2 | 1.2 | 3.1 | 1.5 |
| Tobacco | 1.1 | 0.9 | 1.6 | 0.5 | 1.2 | 0.3 |
| Textiles | 4.0 | 3.2 | 4.7 | 5.4 | 3.6 | 0.7 |
| Apparel | 1.9 | 1.5 | 3.3 | 2.8 | 0.9 | 0.9 |
| Paper | 2.5 | 1.7 | 2.4 | 2.3 | 3.4 | 0.6 |
| Printing, publishing | 2.7 | 2.3 | 4.1 | 2.8 | 2.0 | 0.7 |
| Chemicals | 4.9 | 4.7 | 4.5 | 5.8 | 4.7 | 0.4 |
| Petroleum refining | 3.0 | 3.5 | 1.4 | 4.7 | 2.8 | 0.8 |
| Rubber products | 3.9 | 3.6 | 4.8 | 3.2 | 4.0 | 0.4 |
| Leather products | 1.7 | 1.4 | 3.7 | 0.9 | 0.9 | 0.9 |
| Durables | 2.4 | 2.9 | 0.8 | 1.7 | 3.4 | 0.9 |
| Lumber products | 3.5 | 4.2 | 3.8 | 3.7 | 2.5 | 0.6 |
| Furniture | 2.9 | 2.0 | 4.9 | 3.4 | 2.2 | 1.0 |
| Stone, clay, glass products | 2.4 | 2.9 | 2.3 | 1.3 | 2.7 | 0.4 |
| Primary metals | 1.6 | 1.2 | 1.2 | −0.2 | 3.1 | 1.0 |
| Fabricated metals | 1.9 | 1.8 | 1.1 | 1.5 | 2.6 | 0.5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Machinery excluding electric | 2.6 | 3.1 | 1.3 | 3.0 | 2.8 | 0.6 |
| Electric machinery | 3.7 | 5.0 | 2.5 | 2.3 | 4.2 | 1.0 |
| Transportation equipment and ordnance | 3.2 | 4.8 | 1.0 | 3.3 | 3.2 | 1.0 |
| Instruments | 2.9 | 1.3 | 2.7 | 6.1 | 2.8 | 1.1 |
| Miscellaneous | 3.5 | 1.8 | 3.7 | 4.2 | 4.3 | 0.9 |
| Transportation | 3.4 | 1.9 | 3.2 | 3.4 | 4.9 | 1.0 |
| Railroads | 5.2 | 3.2 | 3.8 | 5.0 | 7.9 | 1.8 |
| Nonrail | 2.1 | 0.1 | 2.4 | 2.3 | 3.5 | 1.1 |
| Local transit | | | n.a. | | | |
| Intercity bus lines | | | n.a. | | | |
| Motor freight transportation | | | n.a. | | | |
| Water transportation | 0.5 | 0.9 | 2.2 | 2.4 | −2.0 | 1.6 |
| Air transportation | 8.0 | 12.3 | 5.1 | 1.6 | 9.7 | 3.5 |
| Pipeline transportation | | | n.a. | | | |
| Communication and public utilities | 4.0 | 4.4 | 3.2 | 4.0 | 4.1 | 0.3 |
| Communication | 3.8 | 4.4 | 2.4 | 4.6 | 4.0 | 0.6 |
| Electric, gas, and sanitary service | 3.9 | 4.4 | 4.0 | 3.2 | 3.8 | 0.3 |
| Electric and gas | 4.9 | 4.8 | 5.6 | 4.3 | 4.7 | 0.4 |
| Trade | 2.5 | 1.8 | 2.4 | 1.8 | 3.6 | 0.7 |
| Wholesale | 2.5 | 1.2 | 2.8 | 2.7 | 3.2 | 0.7 |
| Retail | 2.4 | 2.0 | 2.0 | 1.2 | 3.6 | 0.8 |
| Finance, insurance, and real estate | | | n.a. | | | |
| Services[a] | | | n.a. | | | |
| Average deviation: | | | | | | |
| 7 Industry segments | 0.8 | 1.1 | 0.9 | 1.2 | 1.4 | |
| 34 Industry groups[b] | 1.0 | 1.4 | 1.4 | 1.4 | 1.4 | |

Source: Tables A-20, A-22, A-24, A-26–31, A-33, A-35, A-37–58, A-60, A-62, A-67–68, A-70–71, A-73–77. Here and in subsequent productivity summary tables, average deviations across subperiods are weighted by length of period, while average industry deviations are unweighted.

[a] Excludes households and nonprofit institutions, includes government enterprises, here and in subsequent tables.

[b] Includes two-digit industries and one-digit industries that are not subdivided. Excludes nondurables, durables, nonrail, and electric and gas subcategories.

Average rates of increase ranged from a low of 1.5 per cent a year in contract construction (without adjustment for possible deflator bias) to 4.2 per cent in mining (see Table 5-1). We do not have total factor productivity estimates for the finance and service segments due to lack of capital estimates, but the labor productivity estimates suggest that the rate of increase in finance, insurance, and real estate was about the same rate as in construction, and that the rate of gain in the services segment was even lower—probably under 1 per cent a year in terms of total factor productivity. The real product and productivity estimates for the finance and services sectors may be subject to some downward bias, however, as a result of inadequate output price deflators. (See p. 179 in the appendix.)

The manufacturing and trade segments showed the same average annual rate of gain in total factor productivity as the private domestic business economy as a whole—2.5 per cent. Farming, transportation, and communication and public utilities were higher, with better than 3 per cent average annual increases. (See Chart 5-1.) Compared with the trend rates of increase in the earlier decades 1919-48, for which we had estimates covering five segments, manufacturing and transportation had lower rates of advance in the postwar period, while farming, mining, and communication and public utilities exhibited some acceleration. The residual segment as a whole also appears to have accelerated its rate of productivity advance.[1]

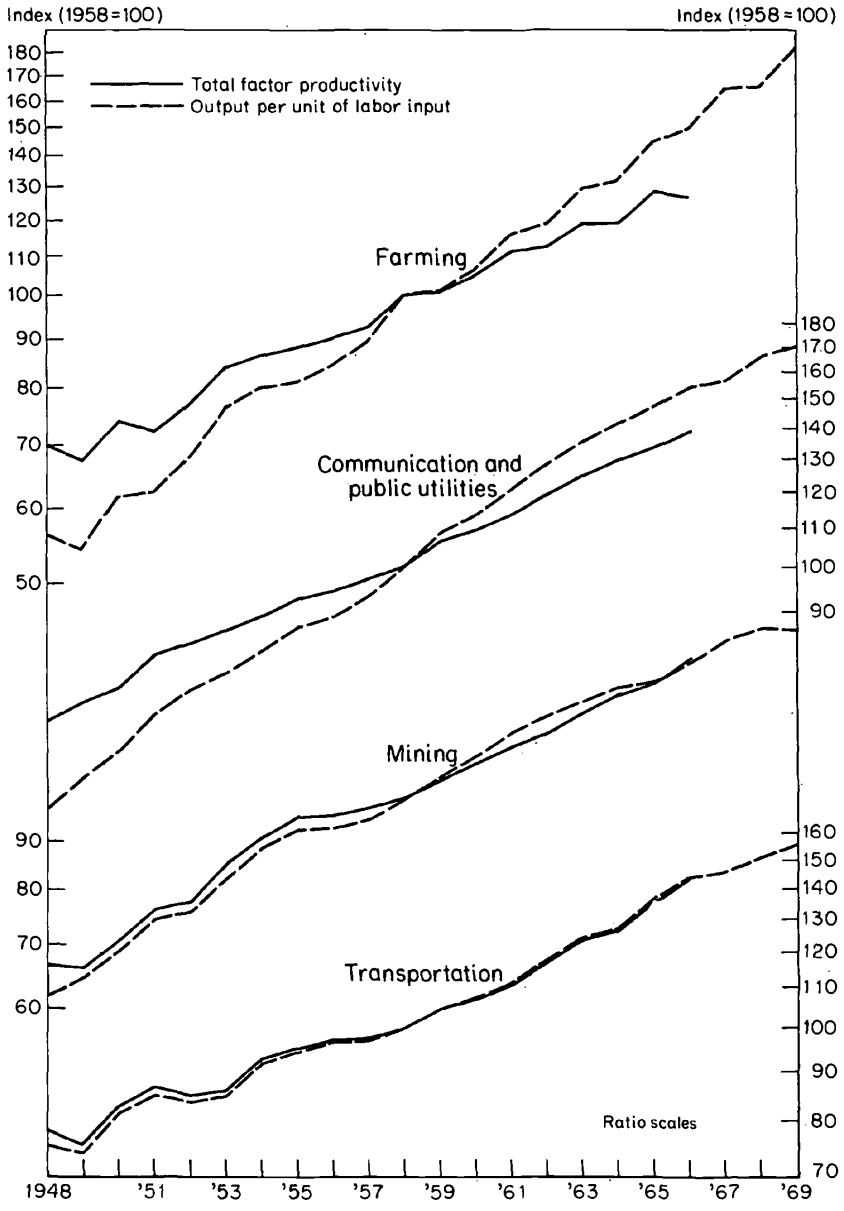
As would be expected, the degree of dispersion in rates of productivity advance in the thirty-four industry groups was somewhat greater than in the seven segments. For example, within transportation, average annual rates of increase ranged from 8.0 per cent in air transportation to 0.5 per cent in water transportation. No group registered a productivity drop. (See Chart 5-2.) As shown at the bottom of Table 5-1, the mean deviation of rates of increase in total factor productivity from the average rate in the business economy as a whole was 1.0 for the industry groups, compared with a 0.8 mean deviation for the segments.

Chart 5-3 contains a frequency distribution of rates of change, 1948-66, in total factor productivity and in the partial productivity ratios (discussed below). The distribution looks quite similar to that in earlier periods. For total factor productivity, annual rates are heavily concentrated in the 1 to 4 per cent classes, with a right skew.

Dispersion of rates of productivity change in most of the four subperiods was somewhat larger than for the period 1948-66 as a whole. For example, in

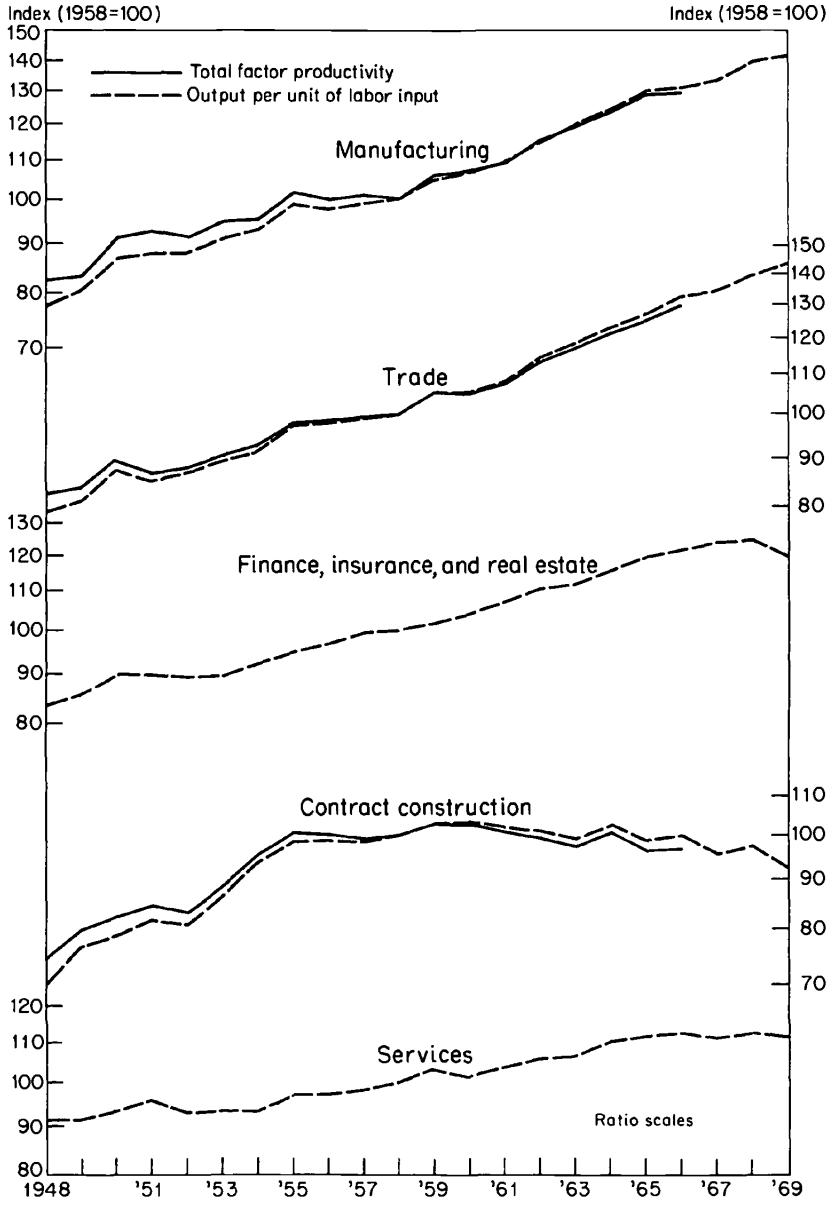
[1] See *Productivity Trends*, Table 34, pp. 136-37, and Table 5-1 above.

Chart 5-1: Private Domestic Business Economy, Industry Segments: Total Factor Productivity (1948–66)[a] and Output per Unit of Labor Input (1948–69)




(continued)

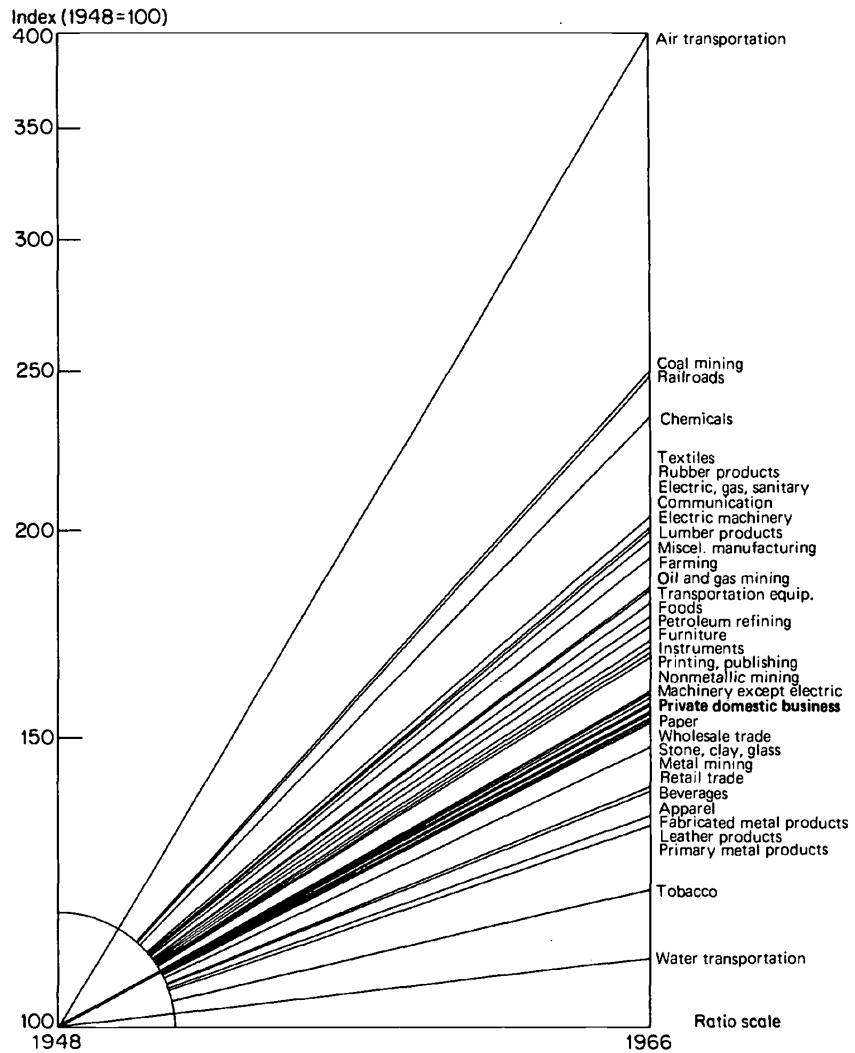
Chart 5-1 (concluded)




Source: Tables A-22, A-24, A-30, A-31, A-58, A-70, A-75, A-78, and A-79.
[a] Not available for finance, insurance, and real estate, and for services.

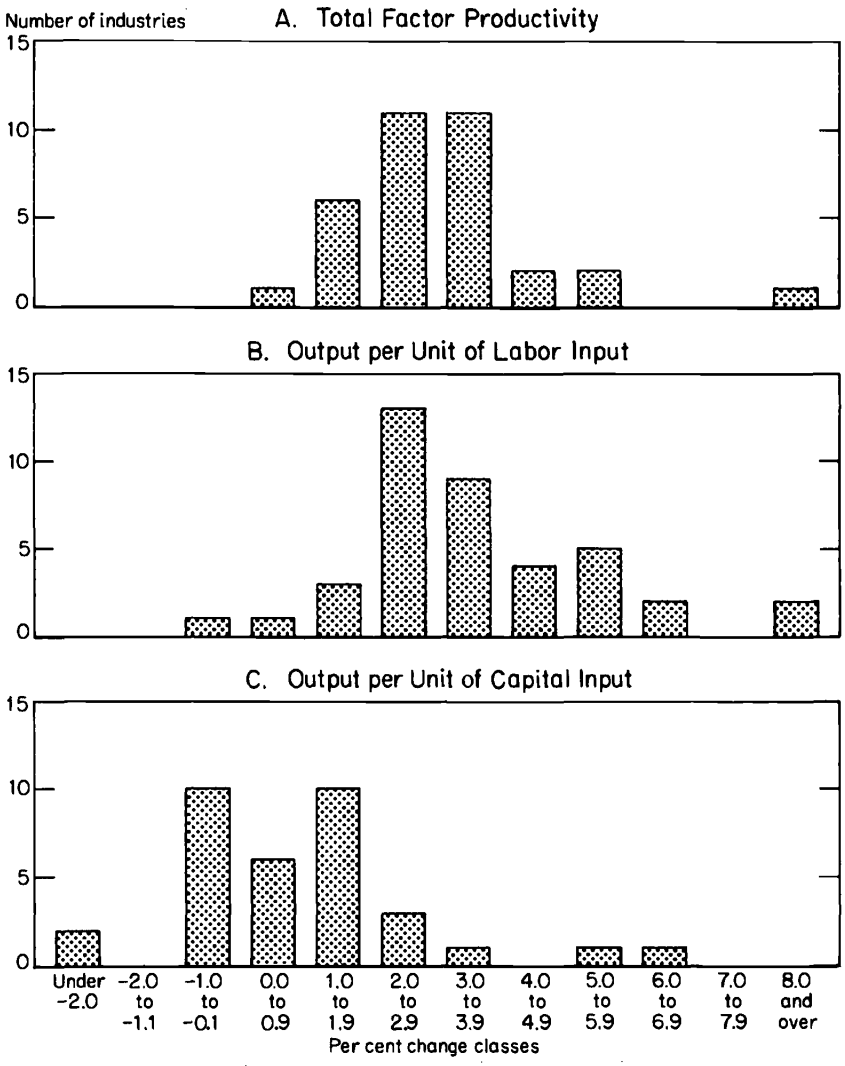
the first subperiod, 1948-53, average rates of increase ranged from 12.3 in air transportation down to 0.1 in beverage manufacturing. In some subperiods there were small productivity declines. The averages of the subperiod mean deviations from rates of productivity change for the business economy were

Chart 5-2: Private Domestic Business Economy, Thirty-three Industry Groups:[a] Divergence of Total Factor Productivity, 1966 Relative to 1948




Source: Tables A-20, A-22, A-26–29, A-37–57, A-60, A-67–8, A-71, A-73, A-76–77.
[a] Excludes contract construction; finance, insurance, and real estate; and services.

Chart 5-3: Private Domestic Business Economy, Thirty-four Industry Groups:[a] Average Annual Rate of Change in Productivity Ratios, 1948–66




Source: Tables 5-1, 5-5, and 5-6.

[a] See note a on each source table. Note that Panel B includes 40 industry groups (see Table 5-5).

1.2 for the seven segments and 1.4 for the thirty-four groups—each 0.4 above the corresponding mean deviation for the eighteen-year period as a whole.

There was more variability in subperiod rates of change in total factor

productivity for most segments and groups than for the business economy as a whole. Even though the subperiod rates are measured between peak years of the business cycles, the rates of capacity utilization probably differed more between the peak years for industry segments and groups than the economy as a whole. This factor, as well as variations in rates of innovation, lies behind the variations in rates of change in total factor productivity—not to mention possible errors in the estimates.

It will be recalled that total factor productivity in the business economy as a whole rose at average rates of close to 3 per cent a year during the first and last subperiods, 1948-53 and 1960-66, and sagged in the two middle subperiods. The same pattern is evident in the total manufacturing segment, particularly in the durable goods subdivision, which experienced a much more pronounced sag in the growth of demand and output than nondurables. The mining segment, dominated by crude petroleum and natural gas, showed a similar pattern, in less pronounced form. The other segments had different patterns. Thus, in farming, the highest rates of increase came in the first and third subperiods, while in trade, the second and fourth subperiods were the strongest. In transportation, the rates of increase gradually accelerated over all four subperiods, while in contract construction the rates steadily decelerated, although deflator bias may be involved in the latter case. In communication and public utilities, only the second subperiod showed some deceleration in rates of productivity advance. (See Table 5-1.)

As measured by the mean deviation of subperiod rates from the rate for the eighteen-year period, the least variability in productivity advance was exhibited by the communication and public utility segment—0.3 per cent. The highest mean deviation was that for the volatile contract construction segment: 1.8 per cent. The mean deviations for the other segments are shown in the last column of Table 5-1.

Patterns of productivity change were even more varied in the industry groups than in the broader segments. The mean deviations of subperiod rates from the total period rates for the given industries averaged 0.94 and 0.77, respectively. In the most volatile group, air transportation, rates of advance swung from better than 12 per cent in 1948-53 down to 1.6 per cent in 1957-60, then back up to almost 10 per cent in 1960-66. A few groups showed productivity drops, but in no more than one of the four subperiods each.

Year-to-year variations in percentage changes in total factor productivity were, of course, much greater than variations in average rates from peak to peak of successive cycles. This reflected not only cyclical influences but also

erratic factors, including possible statistical errors in the estimates. Thus, the mean deviation of annual per cent changes in the segments from their period rates averaged 2.4 per cent (see Table 5-2), compared with a 0.8 per cent mean deviation of subperiod rates from period rates. The corresponding mean deviations for the industry groups were 3.0 and 0.9 per cent.

TABLE 5-2

Private Domestic Business Economy:
Mean Deviations of Subperiod and Annual Rates of Change in Output and Productivity Ratios from Average Annual Rates of Change, 1948-66, by Industry Segment
(per cent)

| Industry Segment | Real Product | Total Factor Productivity | Real Product per Unit of: Labor Input | Real Product per Unit of: Capital Input |
|---|---|---|---|---|
| Private domestic business economy | | | | |
| Period rate | 4.0 | 2.5 | 3.1 | 0.5 |
| Mean deviation | | | | |
| Subperiod | 1.1 | 0.4 | 0.3 | 0.9 |
| Annual | 3.0 | 1.2 | 1.3 | 2.7 |
| Farming | | | | |
| Period rate | 0.9 | 3.3 | 5.6 | 0.2 |
| Mean deviation | | | | |
| Subperiod | 0.6 | 0.5 | 0.7 | 0.7 |
| Annual | 2.9 | 3.2 | 3.8 | 2.8 |
| Mining | | | | |
| Period rate | 2.1 | 4.2 | 4.6 | 2.9 |
| Mean deviation | | | | |
| Subperiod | 1.0 | 0.5 | 0.7 | 2.0 |
| Annual | 4.6 | 2.0 | 1.7 | n.a. |
| Contract construction | | | | |
| Period rate | 3.1 | 1.5 | 2.0 | -3.8 |
| Mean deviation | | | | |
| Subperiod | 1.6 | 1.8 | 1.8 | 0.9 |
| Annual | 3.5 | 3.0 | 2.9 | 4.3 |
| Manufacturing | | | | |
| Period rate | 4.3 | 2.5 | 2.9 | 0.8 |
| Mean deviation | | | | |
| Subperiod | 2.4 | 0.6 | 0.6 | 1.5 |
| Annual | 5.9 | 2.8 | 2.0 | 5.8 |
| Nondurables | | | | |
| Period rate | 3.8 | 2.6 | 3.2 | 0.7 |

(continued)

TABLE 5-2 (continued)

| Industry Segment | Real Product | Total Factor Productivity | Real Product per Unit of Labor Input | Real Product per Unit of Capital Input |
|---|---|---|---|---|
| Mean deviation | | | | |
| Subperiod | 0.9 | 0.1 | 0.2 | 0.1 |
| Annual | 3.6 | 1.9 | 1.3 | 3.6 |
| Durables | | | | |
| Period rate | 4.7 | 2.4 | 2.8 | 0.3 |
| Mean deviation | | | | |
| Subperiod | 3.4 | 0.9 | 0.8 | 1.5 |
| Annual | 7.7 | 3.1 | 2.6 | 7.4 |
| Transportation | | | | |
| Period rate | 2.3 | 3.4 | 3.7 | 0.6 |
| Mean deviation | | | | |
| Subperiod | 2.2 | 1.0 | 0.9 | 2.3 |
| Annual | 4.6 | 2.6 | 2.5 | 4.6 |
| Railroads | | | | |
| Period rate | 0.6 | 5.2 | 5.8 | 0.6 |
| Mean deviation | | | | |
| Subperiod | 2.8 | 1.8 | 1.6 | 3.0 |
| Annual | 6.6 | 3.8 | 3.5 | 6.6 |
| Nonrail | | | | |
| Period rate | 3.7 | 2.1 | 2.3 | -2.4 |
| Mean deviation | | | | |
| Subperiod | 1.5 | 1.1 | 1.0 | 2.6 |
| Annual | 3.6 | 2.7 | 2.7 | 3.8 |
| Communication and public utilities | | | | |
| Period rate | 7.1 | 4.0 | 5.8 | 1.2 |
| Mean deviation | | | | |
| Subperiod | 0.7 | 0.3 | 0.9 | 1.0 |
| Annual | 1.2 | 0.9 | 1.2 | 1.8 |
| Communication | | | | |
| Period rate | 7.0 | 3.8 | 5.5 | 0.7 |
| Mean deviation | | | | |
| Subperiod | 0.8 | 0.6 | 0.9 | 0.8 |
| Annual | 1.9 | 1.4 | 1.9 | 2.4 |
| Electric, gas, and sanitary services | | | | |
| Period rate | 7.1 | 3.9 | 6.1 | 1.5 |
| Mean deviation | | | | |
| Subperiod | 1.2 | 0.3 | 0.9 | 0.8 |
| Annual | 1.6 | 1.3 | 1.6 | 1.7 |

(continued)

TABLE 5-2 (concluded)

| Industry Segment | Real Product | Total Factor Productivity | Real Product per Unit of: Labor Input | Real Product per Unit of: Capital Input |
|---|---|---|---|---|
| Trade | | | | |
| Period rate | 4.1 | 2.5 | 2.9 | 0.0 |
| Mean deviation | | | | |
| Subperiod | 0.6 | 0.7 | 0.7 | 0.8 |
| Annual | 2.6 | 2.0 | 1.8 | 2.7 |
| Wholesale | | | | |
| Period rate | 4.8 | 2.5 | 3.1 | -0.3 |
| Mean deviation | | | | |
| Subperiod | 0.8 | 0.7 | 0.5 | 1.5 |
| Annual | 2.6 | 2.2 | 2.2 | 2.0 |
| Retail | | | | |
| Period rate | 3.7 | 2.4 | 2.7 | 0.0 |
| Mean deviation | | | | |
| Subperiod | 0.8 | 0.8 | 0.8 | 0.5 |
| Annual | 2.6 | 2.1 | 2.0 | 3.1 |
| Finance, insurance, and real estate | | | | |
| Period rate | 5.1 | n.a. | 2.1 | n.a. |
| Mean deviation | | | | |
| Subperiod | 0.3 | n.a. | 0.6 | n.a. |
| Annual | 1.0 | n.a. | 1.1 | n.a. |
| Services | | | | |
| Period rate | 3.5 | n.a. | 1.2 | n.a. |
| Mean deviation | | | | |
| Subperiod | 1.0 | n.a. | 0.4 | n.a. |
| Annual | 1.5 | n.a. | 1.4 | n.a. |
| ADDENDUM | | | | |
| Average mean deviation | | | | |
| Industry segments[a] | | | | |
| Subperiod | 1.2 | 0.8 | 0.8 | 1.3 |
| Annual | 3.1 | 2.4 | 2.0 | 3.7 |
| Industry groups[b] | | | | |
| Subperiod | 1.5 | 0.9 | 0.9 | 2.2 |
| Annual | 4.8 | 3.0 | 2.6 | 5.5 |

Source: Tables 5-1, 5-5, 5-6, 6-1, A-22, A-26–30, A-37–57, A-60, A-64–69, A-71, A-73, A-76–79.

[a] Based on segments (6-9) for which data are available.

[b] Based on groups for which data are available: 40 for real product and real product per unit of labor input, 34 for total factor productivity, and 30 for real product per unit of capital input.

With regard to the cyclical factor in annual variations in total factor productivity, most of the segments showed somewhat smaller percentage

increases in the contraction years 1949, 1954, 1958, and 1961 than during the expansion years. Contract construction was the only exception.[2] A number of the industry groups showed absolute declines during contraction years, but most industries merely exhibited retardation in their rate of productivity advance during contractions. (See Table 5-3.)

TABLE 5-3

Private Domestic Business Economy:
Average Annual Rates of Change in Output and Productivity Ratios, Expansions[a] Versus Contractions, 1948-66, by Industry Segment
(per cent)

| | Real Product | Total Factor Productivity | Real Product per Unit of | |
|---|---|---|---|---|
| | | | Labor Input | Capital Input |
| Private Domestic Business Economy | | | | |
| Expansion | 5.4 | 2.6 | 2.9 | 1.6 |
| Contraction | -0.4 | 2.4 | 3.8 | -3.2 |
| Farming | | | | |
| Expansion | 1.0 | 3.5 | 5.8 | 0.4 |
| Contraction | 0.8 | 3.2 | 5.3 | 0.0 |
| Mining | | | | |
| Expansion | 4.7 | 4.5 | 4.2 | n.a. |
| Contraction | -5.5 | 3.1 | 5.8 | n.a. |
| Contract construction | | | | |
| Expansion | 3.9 | 1.0 | 1.4 | -3.0 |
| Contraction | 0.6 | 3.5 | 4.4 | -5.8 |
| Manufacturing | | | | |
| Expansion | 7.3 | 3.1 | 3.1 | 3.0 |
| Contraction | -5.2 | 0.6 | 2.4 | -6.6 |
| Nondurables | | | | |
| Expansion | 5.3 | 3.1 | 3.4 | 2.0 |
| Contraction | -1.2 | 0.8 | 2.3 | -3.3 |
| Durables | | | | |
| Expansion | 8.8 | 3.0 | 3.0 | 3.3 |
| Contraction | -8.0 | 0.5 | 2.2 | -8.6 |

(continued)

[2] Nathaniel Goldfinger, of the AFL-CIO and a member of the NBER Board of Directors' reading committee for this volume, suggests that this can be explained by layoff and equipment-leasing patterns in construction, which differ significantly from those in other industries.

TABLE 5-3 (concluded)

| | Real Product | Total Factor Productivity | Real Product per Unit of: Labor Input | Real Product per Unit of: Capital Input |
|---|---|---|---|---|
| Transportation | | | | |
| Expansion | 4.6 | 3.8 | 3.8 | 2.8 |
| Contraction | -4.9 | 2.6 | 3.2 | -6.4 |
| Railroads | | | | |
| Expansion | 3.9 | 6.2 | 6.5 | 3.8 |
| Contraction | -9.6 | 2.2 | 3.7 | -9.4 |
| Nonrail | | | | |
| Expansion | 5.0 | 1.9 | 2.1 | -1.0 |
| Contraction | -0.5 | 3.0 | 3.4 | -6.6 |
| Communication and Public Utilities | | | | |
| Expansion | 7.5 | 4.0 | 5.6 | 1.9 |
| Contraction | 5.6 | 3.5 | 6.6 | -1.0 |
| Communication | | | | |
| Expansion | 7.8 | 3.9 | 5.2 | 1.8 |
| Contraction | 4.0 | 3.6 | 6.6 | -2.8 |
| Electric, gas, & sanitary services | | | | |
| Expansion | 7.2 | 4.0 | 6.1 | 1.8 |
| Contraction | 7.1 | 3.6 | 6.1 | 0.4 |
| Trade | | | | |
| Expansion | 5.0 | 2.8 | 3.2 | 0.6 |
| Contraction | 1.0 | 1.4 | 2.0 | -2.4 |
| Wholesale | | | | |
| Expansion | 5.8 | 2.7 | 3.3 | 0.0 |
| Contraction | 1.5 | 1.8 | 2.4 | -1.6 |
| Retail | | | | |
| Expansion | 4.6 | 2.8 | 3.0 | 0.9 |
| Contraction | 0.7 | 1.0 | 1.6 | -2.9 |
| Finance, insurance, and real estate | | | | |
| Expansion | 5.2 | n.a. | 2.0 | n.a. |
| Contraction | 4.6 | n.a. | 2.2 | n.a. |
| Services | | | | |
| Expansion | 4.1 | n.a. | 1.2 | n.a. |
| Contraction | 1.4 | n.a. | 1.0 | n.a. |

Source: Tables A-20, A-22, A-24, A-30–31, A-33, A-35, A-58, A-60, A-62, A-70–71, A-73, A-75–79.

[a] The years 1961-66 were counted as an expansion.

## Capital per Unit of Labor Input

Prior to discussing the behavior of the partial productivity ratios, it is helpful to look at capital per unit of labor input by industry segments and groups. Not only is this ratio of intrinsic interest but it explains the difference between movements of the two partial productivity ratios and those of total factor productivity, and between each other. Take, for example, the average annual growth rate of total factor productivity in the private domestic economy—2.5 per cent—which is, in effect, a weighted average of the rates of increase in output per unit of labor input, 3.1, and in the output-capital ratio of 0.5 per cent. The average annual rate of increase in the capital-labor ratio of 2.6 per cent explains the difference between the rates of increase in the partial productivity ratios. Further, if we weight the 2.6 by the base-period factor shares (roughly 0.27 and 0.73), we obtain 0.7 and 1.9, or close to the differences between the rates of increase in the partial productivity ratio and that of total factor productivity. When this approach is applied to industries, of course, differences among the rates of change of productivity ratios would reflect differences not only in rates of increase in capital per unit of labor input but also in the relative weights of the two factor classes.

Capital per unit of labor input increased significantly in all the several industry segments. (See Table 5-4.) The 2.3 per cent average annual rate of increase in manufacturing and 1.6 per cent in mining were somewhat below the business economy average rate of 2.6; in the other segments the rates were above average. This implies that the rate of increase in the uncovered finance and services segments was somewhat below the business economy average. The dispersion of segment rates of change in the capital-labor ratio, as measured by a mean deviation of 1.4 per cent from the economy rate, is 1.75 times as great as that for total factor productivity. The dispersion of rates of change in the subperiods averages 1.9 per cent, or 1.58 times the corresponding measure for total factor productivity.

Capital per unit of labor input increased in all of the industry groups but one—oil and gas. None of the industry average increases was as high as the 6 per cent a year rate in the construction segment. During all of the subperiods but the last one, 1960-66, there was much greater dispersion in industry group rates than in segment rates, with a number of groups showing declining capital-labor ratios in one or two subperiods.

Variability in subperiod rates of change in capital per unit of labor input was moderate. The mean deviation of the subperiod rates from the 1948-66

TABLE 5-4

Private Domestic Business Economy: Capital per Unit of Labor Input,
by Industry Segment and Group, Average Annual Percentage Rates of Change

| | 1948-66 | 1948-53 | 1953-57 | 1957-60 | 1960-66 | Average Deviation |
|---|---|---|---|---|---|---|
| Private domestic business economy | 2.6 | 3.2 | 3.8 | 2.6 | 1.3 | 0.9 |
| Farming | 5.3 | 7.3 | 4.0 | 3.4 | 5.6 | 1.2 |
| Mining | 1.6 | 3.1 | 1.1 | 7.2 | −2.0 | 2.7 |
| Metal | 3.4 | −0.3 | 9.4 | 13.4 | −2.1 | 5.9 |
| Coal | 5.4 | 10.2 | 1.2 | 11.7 | 1.3 | 4.7 |
| Oil and gas | −3.0 | −4.7 | −3.7 | 3.8 | −4.3 | 2.2 |
| Nonmetal | 3.4 | −0.6 | 6.8 | 3.5 | 4.6 | 2.3 |
| Contract construction | 6.0 | 7.9 | 5.7 | 6.0 | 4.6 | 1.1 |
| Manufacturing | 2.3 | 1.9 | 3.6 | 2.6 | 1.7 | 0.7 |
| Nondurables | 2.4 | 2.7 | 2.4 | 2.1 | 2.4 | 0.1 |
| Foods | 1.5 | 1.0 | −0.3 | 2.3 | 2.9 | 1.1 |
| Beverages | 1.9 | 5.7 | −2.7 | 2.3 | 1.9 | 2.2 |
| Tobacco | 2.8 | −1.2 | 4.2 | 5.4 | 3.9 | 2.2 |
| Textiles | 1.6 | 4.4 | 4.4 | −3.2 | −0.2 | 2.8 |
| Apparel | 3.2 | 3.5 | 0.1 | 3.4 | 4.9 | 1.4 |
| Paper | 2.0 | 2.4 | 4.4 | 0.4 | 1.1 | 1.2 |
| Printing, publishing | 0.9 | 0.7 | −2.7 | 1.0 | 3.6 | 1.8 |
| Chemicals | 3.1 | 4.1 | 2.6 | 2.8 | 2.8 | 0.5 |
| Petroleum refining | 4.4 | 1.5 | 5.8 | 5.6 | 5.5 | 1.7 |
| Rubber products | 0.7 | −2.1 | 2.9 | 2.5 | 0.7 | 1.6 |
| Leather products | 0.8 | 0.0 | 0.0 | 0.5 | 2.0 | 0.8 |
| Durables | 2.5 | 1.7 | 4.6 | 2.6 | 1.5 | 1.0 |
| Lumber products | 3.6 | 5.2 | 0.8 | 0.0 | 6.0 | 2.5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Furniture | 0.2 | −2.3 | 2.0 | 1.3 | 0.6 | 1.4 |
| Stone, clay, glass products | 3.4 | 3.3 | 6.3 | 3.0 | 1.8 | 1.3 |
| Primary metals | 2.9 | 2.5 | 3.1 | 7.8 | 0.8 | 1.7 |
| Fabricated metals | 2.4 | 2.3 | 3.3 | 3.0 | 1.6 | 0.6 |
| Machinery excluding electric | 0.8 | 1.4 | 4.0 | −1.3 | −0.6 | 1.7 |
| Electric machinery | 2.6 | 1.9 | 4.6 | −0.9 | 3.8 | 1.6 |
| Transportation equipment and ordnance | 1.7 | −3.0 | 6.6 | 2.3 | 2.3 | 2.7 |
| Instruments | 4.4 | 6.3 | 6.0 | 4.0 | 2.1 | 1.7 |
| Miscellaneous | 3.3 | 8.9 | 6.2 | 0.1 | −1.4 | 4.3 |
| Transportation | 3.0 | 4.6 | 3.3 | 4.4 | 0.9 | 1.4 |
| Railroads | 5.2 | 6.3 | 5.2 | 7.9 | 3.0 | 1.5 |
| Nonrail | 4.8 | 8.1 | 5.1 | 4.6 | 2.1 | 1.9 |
| Local transit and intercity bus lines | | | n.a. | | | |
| Motor freight transportation | | | n.a. | | | |
| Water transportation | 2.9 | −0.2 | −0.3 | 13.8 | 2.4 | 3.6 |
| Air transportation | 2.0 | −5.7 | 6.6 | 9.4 | 2.1 | 4.4 |
| Pipeline transportation | | | n.a. | | | |
| Communication and public utilities | 4.5 | 6.1 | 4.1 | 6.3 | 2.4 | 1.5 |
| Communication | 4.7 | 4.2 | 3.7 | 8.4 | 4.1 | 1.2 |
| Electric, gas, and sanitary services | 4.5 | 7.0 | 5.0 | 4.4 | 2.3 | 1.6 |
| Electric and gas | 4.5 | 7.0 | 5.0 | 4.5 | 2.3 | 1.5 |
| Trade | 2.9 | 4.1 | 2.5 | 1.0 | 3.2 | 0.8 |
| Wholesale | 3.5 | 5.5 | 3.5 | 1.4 | 2.8 | 1.1 |
| Retail | 2.7 | 3.5 | 2.0 | 0.8 | 3.4 | 0.9 |
| Finance, insurance, and real estate | | | n.a. | | | |
| Services | | | n.a. | | | |
| Average deviation | | | | | | |
| 7 Industry segments | 1.4 | 2.2 | 1.0 | 2.3 | 2.1 | |
| 34 Industry groups[a] | 1.4 | 3.1 | 2.3 | 3.0 | 1 9 | |

Source: See source for Table 5-1.

[a] Includes two-digit industries and one-digit industries that are not subdivided. Excludes nondurables, durables, nonrail, and electric and gas subcategories.

TABLE 5-5

Private Domestic Business Economy: Output per Unit of Labor Input, by Industry Segment and Group, Average Annual Percentage Rates of Change

| | 1948-66 | 1948-53 | 1953-57 | 1957-60 | 1960-66 | Average Deviation |
|---|---|---|---|---|---|---|
| Private domestic business economy | 3.1 | 3.5 | 2.6 | 2.9 | 3.2 | 0.3 |
| Farming | 5.6 | 6.4 | 4.1 | 5.9 | 5.8 | 0.7 |
| Mining | 4.6 | 5.9 | 3.6 | 5.1 | 3.8 | 0.9 |
| Metal | 2.9 | 1.4 | 2.8 | 3.3 | 4.2 | 0.9 |
| Coal | 5.8 | 4.7 | 7.0 | 5.8 | 5.8 | 0.6 |
| Oil and gas | 2.3 | 0.9 | 0.8 | 3.8 | 3.7 | 1.4 |
| Nonmetal | 3.2 | 2.2 | 4.7 | 5.1 | 2.2 | 1.3 |
| Contract construction | 2.0 | 4.4 | 3.2 | 1.5 | −0.5 | 1.8 |
| Manufacturing | 2.9 | 3.3 | 2.1 | 2.5 | 3.5 | 0.6 |
| Nondurables | 3.2 | 3.3 | 3.1 | 2.9 | 3.4 | 0.2 |
| Foods | 3.4 | 2.4 | 4.0 | 4.4 | 3.2 | 0.6 |
| Beverages | 2.9 | 2.3 | 3.4 | 1.9 | 3.7 | 0.7 |
| Tobacco | 2.7 | 0.2 | 3.9 | 3.6 | 3.6 | 1.4 |
| Textiles | 4.3 | 4.2 | 5.2 | 4.9 | 3.6 | 0.6 |
| Apparel | 2.2 | 1.9 | 3.3 | 3.0 | 1.5 | 0.7 |
| Paper | 3.0 | 2.5 | 3.3 | 2.4 | 3.7 | 0.5 |
| Printing, publishing | 2.7 | 2.3 | 3.9 | 2.8 | 2.3 | 0.5 |
| Chemicals | 6.0 | 6.3 | 5.4 | 6.7 | 5.8 | 0.4 |
| Petroleum refining | 5.5 | 4.6 | 4.1 | 7.7 | 6.0 | 1.1 |
| Rubber products | 4.0 | 3.1 | 5.2 | 3.7 | 4.2 | 0.6 |
| Leather products | 1.7 | 1.4 | 3.6 | 1.0 | 1.1 | 0.8 |
| Durables | 2.8 | 3.3 | 1.4 | 2.1 | 3.6 | 0.8 |
| Lumber products | 3.9 | 5.0 | 3.9 | 3.7 | 3.2 | 0.6 |
| Furniture | 2.9 | 1.8 | 5.0 | 3.5 | 2.2 | 1.1 |
| Stone, clay, glass products | 3.2 | 3.6 | 3.6 | 2.0 | 3.2 | 0.4 |
| Primary metals | 2.1 | 1.8 | 1.7 | 1.1 | 3.2 | 0.7 |
| Fabricated metals | 2.2 | 2.3 | 1.4 | 1.8 | 2.8 | 0.4 |
| Machinery excluding electric | 2.7 | 3.4 | 1.7 | 2.9 | 2.7 | 0.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electric machinery | 4.1 | 5.4 | 3.1 | 2.2 | 4.6 | 1.1 |
| Transportation equipment and ordnance | 3.2 | 4.0 | 1.6 | 3.6 | 3.4 | 0.7 |
| Instruments | 3.7 | 2.5 | 3.7 | 6.8 | 3.2 | 1.0 |
| Miscellaneous | 4.0 | 3.2 | 4.4 | 4.3 | 4.1 | 0.4 |
| Transportation | 3.7 | 2.4 | 3.4 | 3.5 | 5.0 | 0.9 |
| Railroads | 5.8 | 4.3 | 4.2 | 5.7 | 8.2 | 1.6 |
| Nonrail | 2.3 | 0.6 | 2.5 | 2.4 | 3.6 | 1.0 |
| Local transit | -1.0 | 0.3 | 1.3 | -4.3 | -1.9 | 1.7 |
| Intercity bus lines | 1.5 | 4.0 | 1.0 | -0.3 | 0.9 | 1.3 |
| Motor freight transportation | 3.1 | 2.6 | 2.5 | 3.7 | 3.5 | 0.5 |
| Water transportation | 0.7 | 0.7 | 2.2 | 3.1 | -1.5 | 1.5 |
| Air transportation | 8.2 | 11.8 | 5.7 | 2.6 | 10.0 | 3.1 |
| Pipeline transportation | 9.1 | 10.3 | 8.2 | 6.3 | 10.0 | 1.3 |
| Communication and public utilities | 5.8 | 6.7 | 4.7 | 6.8 | 5.2 | 0.9 |
| Communication | 5.5 | 5.4 | 3.6 | 7.6 | 5.7 | 0.9 |
| Electric, gas, and sanitary services | 6.1 | 7.6 | 6.3 | 5.4 | 5.1 | 0.9 |
| Electric and gas | 7.1 | 8.0 | 7.9 | 6.6 | 5.9 | 0.9 |
| Trade | 2.9 | 2.5 | 2.7 | 1.9 | 3.9 | 0.7 |
| Wholesale | 3.1 | 2.2 | 3.3 | 2.9 | 3.7 | 0.5 |
| Retail | 2.7 | 2.6 | 2.2 | 1.2 | 3.8 | 0.8 |
| Finance, insurance, and real estate | 2.1 | 1.5 | 2.7 | 1.5 | 2.6 | 0.6 |
| Services | 1.2 | 0.5 | 1.2 | 1.1 | 1.7 | 0.4 |
| Average deviation: | | | | | | |
| 9 industry segments | 1.3 | 1.9 | 0.8 | 1.8 | 1.5 | |
| 40 industry groups[a] | 1.4 | 1.8 | 1.5 | 1.7 | 1.7 | |

Source: See source for Table 5-1; also, Tables A-64–66, A-69, A-78–79.

[a] Includes two-digit industries and one-digit industries that are not subdivided. Excludes nondurables, durables, nonrail, and electric and gas subcategories.

rate was 0.9 in the business economy as a whole. The average subperiod variability for the segments was somewhat greater, and that for the industry groups much greater—the mean deviations averaging 1.3 and 2.0, respectively. Variability in annual changes would obviously be still larger than subperiod variability, since year-to-year changes in labor input tend to vary much more than the annual changes in real capital stocks and inputs, particularly in recession periods, when stocks continue to grow while man-hours tend to fall, or increase only at much retarded rates.

## Output per Unit of Labor Input

Since there was relative substitution of capital for labor in all segments and groups but one, rates of increase in output per unit of labor input were higher than (or equal to) growth rates of total factor productivity in all but one. Although at a higher level, patterns of change were quite similar in the two sets of productivity measures, so our summary of output per unit of labor input can be brief, except for special reference to the groupings for which we have labor productivity but no total factor productivity measures.

In looking at the period as a whole, average annual rates of increase in labor productivity in the segments ranged from 5.8 per cent in communication and public utilities and 5.6 per cent in farming down to 1.2 per cent in services, for which we did not have capital and total factor productivity measures. (See Table 5-5.) In the finance, insurance, and real estate segment, for which total productivity measures are also lacking, labor productivity rose at an average annual rate of 2.1 per cent, very close to that for contract construction, and well below the 3.1 per cent average in the business economy as a whole. At a 2.9 per cent a year growth, manufacturing and trade were only slightly under the business average, while mining and transportation were well above it.

The range of change was greater for the industry groups, varying from a 9.1 per cent a year average increase for pipelines down to a −1.0 for local transit. Neither of these industry groups was included in those for which we had total factor productivity measures. Local transit is the only group showing a productivity drop over the period as a whole, associated with a substantial decline in output and with increasing traffic congestion in metropolitan areas. Oil and gas production was the only group in which labor productivity rose less than total factor productivity, since it is the one with a declining capital-labor ratio.

Even in the subperiods, only three groups other than local transit showed

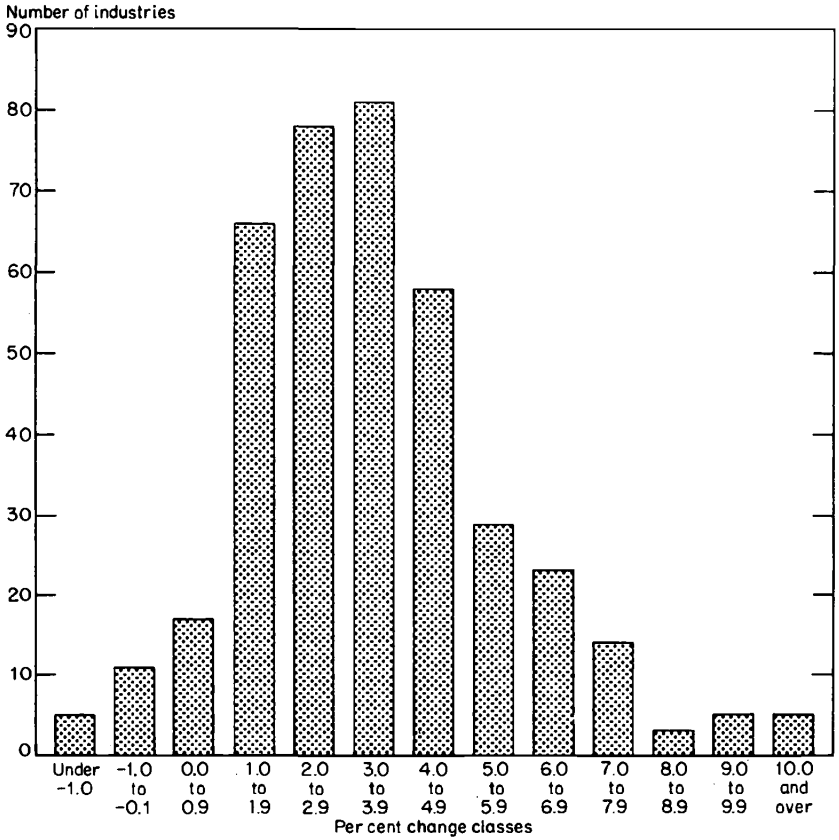
declines in output per unit of labor input, and these for only one subperiod each. Air transportation and pipelines each showed rates of increase of 10 per cent or more in two subperiods each. But in general, the dispersion of rates of change in labor productivity in the subperiods did not average much more than the dispersion of rates for the entire period 1948-66. (See bottom lines of Table 5-5.)

Dispersion of rates of change in output per unit of labor input, by segment and industry group, is significantly greater than that for total factor productivity. This is not surprising in view of the still larger dispersion in rates of change in capital per unit of labor input. (See Table 5-5 for the mean deviations.) The frequency distribution of group rates of labor productivity change (Chart 5-3, panel B) graphically shows the greater dispersion, as well as more skewness to the right. As was true of total factor productivity, dispersion of rates of increase in labor productivity was, on the average, a bit higher in the subperiods than over the 1948-66 period as a whole. It was also slightly higher for the forty industry groups than the nine segments.

In addition to the data for these industry groups and segments, we also had access to index numbers of output per man-hour for 395 four-digit manufacturing industries for the years 1954, 1958, and 1963, based on the Census Bureau production indexes.[3] The years covered were all years of somewhat less than full employment, so the comparisons should not be greatly affected by cyclical factors. As shown in the frequency distribution in Chart 5-4, the dispersion of rates of change for the period 1954-63 is greater than that for the forty industry groups for the period 1948-66. In part, the greater dispersion reflects the fact that the comparison period is only half as long. But more importantly, it reflects the far larger number of four-digit industries available for comparison. The largest number of industries, eighty-one, fell into the 3 to 4 per cent class interval—the mean rate of growth for all 395 industries was 3.5 per cent. About three-quarters of the industries showed average rates of increase between 1 and 5 per cent. There was a definite right skew to the distribution, with over twice as many industries showing rates of increase in excess of 5 per cent as those showing increases of less than 1 per cent. Whereas none of the two-digit groups showed increases of more than 10 per cent, five four-digit industries did: pharmaceutical preparations, cathode ray picture tubes, industrial gases, explosives, and

[3] The production indexes were related to indexes of man-hour estimates prepared by Henry Linsert for a master's thesis under my supervision, "An Empirical Study of the Relationships Between Output per Man-Hour and Related Variables in Manufacturing Industries, 1954-1963," June 1970, on file at The George Washington University Library.

Chart 5-4: Frequency Distribution of Average Annual Rates of Change in Output per Man-Hour, 395 Industries, 1954-63




Source: See Chapter 5, footnote 3.

tufted carpets and rugs. While only one two-digit group showed a decline, five four-digit industries did: raw cane sugar, metal foil and leaf, plating and polishing, automatic vending machines, and primary nonferrous metals, n.e.c.

Surprisingly, the variability of subperiod rates of change in labor productivity was no greater than that in total factor productivity. The average deviation in the business economy of subperiod rates of change from the period mean rate of increase in labor productivity was 0.3 per cent, compared with 0.4 per cent for total factor productivity. The comparable mean average deviations for the segments and industry groups were 0.8 and 0.9 per cent,

exactly the same percentages as those for total factor productivity. Annual variability of per cent changes in labor productivity was, of course, much greater than the subperiod variability. The average deviations of annual per cent changes from the long-period rate of change were 2.0 per cent for the segments and 2.6 for the industry groups—somewhat below the comparable measures for total factor productivity, since labor can be more readily adjusted to output changes than capital. (See Table 5-2 above.) In fact, labor productivity in the business economy rose more in contractions than in expansions, although the reverse was true for about one-third of the industry groups. It dropped absolutely during contraction years in three of the groups: primary metal products, local transit, and intercity bus lines. Apparently, firms in these industries had more difficulty in adjusting man-hours worked to declines in output than those in the eighteen other industry groups where output fell in contraction years. (See reference in Table 5-2).

## Output per Unit of Capital Input

Despite the substantial and widespread increases in capital per unit of labor input during the postwar period, significant economies in the use of capital per unit of output were also realized at the same time in almost all industry segments and groups. It will be recalled that real product per unit of capital input ("capital productivity") rose at an average annual rate of 0.5 per cent in the business economy. It fell in only one segment, contract construction, remained unchanged in trade as a whole, and averaged annual increases in the other segments ranging from 0.2 per cent in farming to 2.9 per cent in mining (see Table 5-6).

The range of change was wider in the industry groups. About one-third of the groups showed moderate declines in the output-capital ratio. Most of the increases were also moderate, but oil and gas, as well as airlines, showed average gains in capital productivity of more than 5 per cent a year. The average deviations of segment and group rates of change from their means were 1.2 and 1.3 per cent, respectively, about the same as for labor productivity changes. The average deviations in the subperiods were much greater, particularly for the group rates of change from their mean. There were more declines in capital productivity in the first three subperiods than over the period as a whole, and the range of change was greater. By the last subperiod, 1960-66, there was a larger proportion of groups with substantial increases, which was reflected in an accelerated rate of advance in capital productivity averaging 1.8 per cent for the business economy as a whole. Between 1966

TABLE 5-6

Private Domestic Business Economy: Output per Unit of Capital Input, by Industry Segment and Group, Average Annual Percentage Rates of Change

| | 1948-66 | 1948-53 | 1953-57 | 1957-60 | 1960-66 | Average Deviation |
|---|---|---|---|---|---|---|
| Private domestic business economy | 0.5 | 0.3 | −1.2 | 0.3 | 1.8 | 0.9 |
| Farming | 0.2 | −0.8 | 0.1 | 2.3 | 0.2 | 0.7 |
| Mining | 2.9 | 2.7 | 2.5 | −2.0 | 5.9 | 2.0 |
| Metal | −0.4 | 1.7 | −6.0 | −8.8 | 6.4 | 5.5 |
| Coal | 0.4 | −4.9 | 5.7 | −5.3 | 4.4 | 4.9 |
| Oil and gas | 5.4 | 5.9 | 4.6 | 0.0 | 8.3 | 2.2 |
| Nonmetal | −0.2 | 2.8 | −2.1 | 1.6 | −2.3 | 2.3 |
| Contract construction | −3.8 | −3.3 | −2.4 | −4.2 | −4.9 | 0.9 |
| Manufacturing | 0.8 | 0.9 | −2.1 | 0.2 | 3.1 | 1.5 |
| Nondurables | 0.7 | 0.6 | 0.6 | 0.7 | 1.0 | 0.2 |
| Foods | 1.8 | 1.4 | 4.1 | 2.1 | 0.3 | 1.2 |
| Beverages | 1.0 | −3.2 | 6.3 | −0.4 | 1.8 | 2.8 |
| Tobacco | −0.1 | 1.4 | −0.3 | −1.8 | −0.1 | 0.7 |
| Textiles | 2.7 | −0.2 | 0.8 | 8.4 | 3.8 | 2.6 |
| Apparel | −0.9 | −1.6 | 3.2 | −0.3 | −3.3 | 2.0 |
| Paper | 1.0 | 0.1 | −1.1 | 2.0 | 2.6 | 1.4 |
| Printing, publishing | 1.8 | 1.7 | 6.7 | 1.9 | −1.3 | 2.2 |
| Chemicals | 2.8 | 2.2 | 2.7 | 3.8 | 2.9 | 0.4 |
| Petroleum refining | 1.0 | 3.0 | −1.6 | 2.0 | 0.5 | 1.5 |
| Rubber products | 3.3 | 5.3 | 2.3 | 1.2 | 3.5 | 1.2 |
| Leather products | 1.0 | 1.4 | 3.6 | 0.4 | −0.9 | 1.4 |
| Durables | 0.3 | 1.5 | −3.1 | −0.6 | 2.1 | 1.8 |
| Lumber products | 0.3 | −0.2 | 3.1 | 3.7 | −2.7 | 2.3 |
| Furniture | 2.7 | 4.3 | 3.0 | 2.1 | 1.6 | 1.0 |
| Stone, clay, glass products | −0.2 | 0.3 | −2.5 | −1.0 | 1.4 | 1.3 |
| Primary metals | −0.7 | −0.6 | −1.3 | −6.2 | 2.4 | 2.1 |
| Fabricated metals | −0.3 | −0.1 | −2.2 | −1.2 | 1.2 | 1.1 |
| Machinery excluding electric | 1.9 | 2.0 | −1.5 | 3.4 | 3.3 | 1.7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electric machinery | 1.5 | 3.5 | −1.5 | 3.1 | 1.0 | 1.7 |
| Transportation equipment and ordnance | 1.5 | 7.3 | −4.8 | 1.2 | 1.1 | 3.2 |
| Instruments | −0.7 | −3.6 | −2.2 | 2.7 | 1.2 | 3.2 |
| Miscellaneous | 0.6 | −5.2 | −1.6 | 4.1 | 5.6 | 4.4 |
| Transportation | 0.6 | −2.1 | 0.0 | −0.9 | 4.1 | 2.3 |
| Railroads | 0.6 | −1.9 | −0.9 | −2.0 | 5.1 | 3.0 |
| Nonrail | −2.4 | −6.9 | −2.5 | −2.2 | 1.5 | 2.6 |
| Local transit | | | n.a. | | | |
| Intercity bus lines | | | n.a. | | | |
| Motor freight transportation | | | n.a. | | | |
| Water transportation | −2.1 | 0.9 | 2.5 | −9.4 | −3.8 | 3.6 |
| Air transportation | 6.1 | 18.5 | −0.9 | −6.2 | 7.7 | 7.6 |
| Pipeline transportation | | | n.a. | | | |
| Communication and public utilities | 1.2 | 0.5 | 0.6 | 0.4 | 2.7 | 1.0 |
| Communication | 0.7 | 1.2 | −0.1 | −0.7 | 1.6 | 0.8 |
| Electric, gas, and sanitary services | 1.5 | 0.6 | 1.3 | 1.0 | 2.7 | 0.8 |
| Electric and gas | 2.4 | 1.0 | 2.8 | 2.0 | 3.5 | 0.9 |
| Trade | 0.0 | −1.6 | 0.1 | 0.9 | 0.6 | 0.8 |
| Wholesale | −0.3 | −3.1 | −0.1 | 1.5 | 0.9 | 1.5 |
| Retail | 0.0 | −0.9 | 0.2 | 0.4 | 0.4 | 0.5 |
| Finance, insurance, and real estate | | | n.a. | | | |
| Services | | | n.a. | | | |
| Average Deviation | | | | | | |
| 7 Industry segments | 1.2 | 1.7 | 1.6 | 1.6 | 2.6 | |
| 34 Industry groups[a] | 1.3 | 2.7 | 2.6 | 2.8 | 2.3 | |

Source: See source for Table 5-1.

[a] Includes two-digit industries and one-digit industries that are not subdivided. Excludes nondurables, durables, nonrail, and electric and gas subcategories.

and 1969, however, capital productivity fell in the business economy and in most segments as the growth of output decelerated sharply.

Average deviations of subperiod rates from average period rates of change in capital were well above the corresponding measures for total and labor productivity. (See last column of Table 5-6.) This indicates the problems of adjusting the rate of capital accumulation to the growth of sales and output, even abstracting from cyclical variations in the latter. The average deviations of annual per cent changes in capital productivity from their mean were 3.7 and 5.5 per cent for the segments and groups, respectively. (See Table 5-2 above.) These high mean deviations are not surprising in view of the fact that real capital stocks and inputs rise in most segments and groups even in contractions, when output is falling in most. On the average, output per unit of capital productivity fell by 3.2 per cent during contractions, and rose by an average 1.6 per cent in expansion years (see Table 5-3 above). Of the six segments for which capital productivity changes were available, the rates fell during contraction years in all except farming, which showed no change.

## Summary Comparison of Dispersion and Variability Measures

The average deviations of segment and group rates of change in real product, productivity, and capital-labor ratios from their means are summarized in Table 5-7. It will be noted that the average deviations for total factor

TABLE 5-7

Private Domestic Business Economy: Summary of Measures of Dispersion in Rates of Change in Output, Productivity, and Input Ratios, by Industry Segment and Group, 1948-66 and Subperiods

| | Real Product | Total Factor Productivity | Output per Unit of: Labor Input | Output per Unit of: Capital Input | Capital per Unit of Labor Input |
|---|---|---|---|---|---|
| Period 1948-66 | | | | | |
| Segments | 1.4 | 0.8 | 1.3 | 1.2 | 1.4 |
| Groups | 2.2 | 1.0 | 1.4 | 1.3 | 1.3 |
| Subperiod averages[a] | | | | | |
| Segments | 1.8 | 1.2 | 1.5 | 1.9 | 1.9 |
| Groups | 2.8 | 1.4 | 1.7 | 2.6 | 2.6 |

Source: Tables 5-1, 5-4–6, 6-1.

[a] Averages of average deviations of rates of change for the four subperiods 1948-53, 1953-57, 1957-60, and 1960-66.

productivity in both segments and groups are well below the corresponding average deviations for the two partial productivity ratios. As demonstrated in *Productivity Trends,*[4] this indicates a positive correlation between rates of change in output per unit of labor input and in capital per unit of labor input. A regression between these two variables for the thirty-two industry groups over the period 1948-66 was run, and the coefficient of correlation was 0.42, significant at the 0.05 level. The correlations for the subperiods were also positive, but less significant.

The dispersion of rates of change for the period 1948-66 in the two partial productivity ratios is almost the same in absolute terms. However, in relative terms, as measured by the coefficient of variation, dispersion in rates of change in capital productivity is much higher, since its secular rate of growth averages only 0.5 per cent a year, compared with 3.1 for output per unit of labor input.

It has been noted that dispersion in the subperiods tends to be higher than dispersion over the entire period covered. This is markedly the case with the output-capital measures, reflecting the long-term nature of the adjustment of capital to output requirements.

With regard to variability of rates of change in the subperiods compared with the average rate of change over 1948-66, average deviations for both total factor productivity and labor productivity averaged 0.8 and 0.9 per cent for the segments and industry groups, respectively. (See Table 5-2, addendum.) This was considerably below the variability prevailing in the earlier decades from 1889 to 1948, reflecting primarily the lesser variability in subperiod rates of growth in real product, by segment and group.[5] For capital productivity, the average mean deviation was considerably higher, at 1.3 per cent, illustrating the difficulties of adjusting real capital stocks to output and the resulting variations in capacity utilization even in peak years. Here, too, variability was smaller than in the decades prior to 1948, a reflection of the smoother pace of economic growth in the postwar period.

The fact that mean deviations of subperiod growth rates in total factor productivity from the 1948-66 average were less than a weighted average of the mean deviations of the two partial productivity ratios from their average rates indicates a positive correlation between subperiod rates of change in labor productivity and capital per unit of labor input. This correlation is not significant with respect to annual changes, however, since the underlying

[4] p. 170.

[5] See *Productivity Trends*, Table 47, p. 173.

relationship is obscured by cyclical factors: since we do not adjust capital stocks and inputs for changes in rates of capital utilization, capital per unit of labor input rises sharply in most industries in recession years, while labor productivity in many segments and groups falls or rises less than in expansion years.

The annual deviation of per cent changes in total factor productivity from the 1948-66 average rate is 2.4 per cent for the industry segments, nearly reaching the average rate of growth itself. For the industry groups, the annual deviation, at 3.0 per cent, surpasses the average rate of growth. In the case of labor productivity changes, average deviations are a bit smaller, and stay below the trend rate for the groups as well as the segments. As to capital productivity changes, average annual deviations from the trend rates are very high for both segments and groups, as would be expected given the concept used in estimating capital. (See Table 5-2, addendum.)