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PART II

INDUSTRY GROUPS

Rather than treat each industry segment separately (as was done in *Productivity Trends*, Appendixes B through K), we shall discuss them together here, since many of the same sources and methods were used for each individually. Following the initial section on classification, we shall look at the estimates of gross output, real product, labor input, capital input, total input, and productivity indexes. The index numbers of outputs, inputs, and productivity ratios for the various industry groups and components are presented consecutively beginning with Table A-22.

Classification

The industry classifications in terms of which the output, input, and productivity estimates are presented from 1948 forward follow the 1957 Standard Industrial Classification (SIC). This is in line with the 1965-66 revisions of the OBE national income and product accounts.[14] In our earlier work, the industry estimates conformed to the 1942 SIC, with the modifications described in OBE's *National Income*, 1954 edition. The new OBE estimates for years prior to 1948 are still based on the old classification, since the data for earlier years could not be adapted to the revised SIC.

Estimates of national income and other variables presented by industry are shown according to both classifications for 1948 by OBE in order to indicate the magnitudes of the differences occasioned by the classification revision. Among major industry groupings, the changes resulted primarily in shifting income and product from trade to manufacturing and services. Many two-digit industries were affected little or not at all. A few of the former two-digit

[14] See *Survey of Current Business*, August 1965; and *The National Income and Product Accounts of the United States*, 1929-1965, Statistical Tables (1966).

groups were merged, notably the bituminous and anthracite coal groups and the ferrous and nonferrous primary metals groups. Conversely, instruments were broken out of the miscellaneous manufactures group and added as a separate two-digit group.

The conceptual revisions described in Part I above affected several industries significantly. The 1958 gross product for services including households was reduced by $5.9 billion because of the elimination of interest paid by consumers from income. The total for real estate, on the other hand, was raised by $12 billion, reflecting the capitalization of real estate commissions. The totals for manufacturing, mining, and contract construction decreased slightly due to exclusion of small tools and similar outlays charged to current expense from capital consumption allowances. Other conceptual revisions resulted in only minor changes, or none at all, in industry estimates. The statistical revisions generally had little effect.

Output

First on the agenda are the OBE real industry product estimates. These have become available for major nonfarm industries since *Productivity Trends* appeared, and we now use them for productivity comparisons since they are conceptually consistent with the overall estimates of real product in the private domestic economy. But we use gross output indexes for two-digit industry groups, for which real product estimates are not published (and may be less stable, as explained below). We also present alternative productivity estimates based on gross output indexes for some broader groupings in order to continue series given in the earlier study, even though real product estimates are also shown. In the second section below, we describe the gross output estimates used, and compare their trends with those of real product where both sets of series are available.

Real Industry Product

The OBE estimates of gross product originating in broad industry groupings, in current and constant prices, were first published for the private nonfarm economy in October 1962. The estimates were revised to conform to the 1965-66 conceptual and statistical changes in the income and product accounts, and presented to the public in April 1967. The initial and revised estimates were described in considerable detail in *Survey of Current Business* articles and in supplementary documents made available by OBE on request; further detailed descriptions of the estimates for the manufacturing and

service groups were prepared by staff members of OBE in connection with the Conference on Research in Income and Wealth. In view of the more or less extensive documentation concerning sources and methods used in making the OBE estimates, we shall only summarize briefly the technical aspects of the series, and attempt to point out some of the limitations and qualifications that must attach to their use for production and productivity analysis.

In principle, real industry product estimates represent the gross value of output less the cost of intermediate products consumed in the production process, each deflated by appropriate price indexes. Given perfectly consistent value estimates and price deflators for intermediate and final products, the sum of real industry product would equal real product obtained by deflating purchases of final goods and services, by type. Even perfect consistency would not mean that the aggregate and industry estimates were necessarily correct. In the case of the OBE estimates, as noted above, some of the price deflators, particularly in the new construction and finance-services area, are subject to upward bias, which is also true of the gross industry output deflators in these areas. This means that both real final expenditures and real industry product estimates may consistently tend to understate growth. Further, both sets of current value estimates could be subject to errors in the same direction which would not necessarily show in reconciliation tables—although we have no reason to believe this to be the case.

More to the point, the preferred double-deflation method could be applied only in industries accounting for about 50 per cent of total product originating in the private domestic business economy in 1958—directly applied in farming, and indirectly in contract construction, manufacturing, railroads, and gas and electric utilities. In farming, the basic estimates (drawn from Department of Agriculture data) of value of output less intermediate product purchases equaled gross product originating as the sum of factor costs plus nonfactor charges against product.[15] In this industry, then, real product could be obtained directly by the double-deflation approach. In the other industries listed above, the available estimates of gross values of output and of intermediate product purchases did not reconcile with gross product originating, built up from the income side, due primarily to incomplete information on intermediate costs obtained, for example, from the Census of Manufactures. In these cases, the implicit deflators obtained as quotients of the differences in current and constant dollar flows were applied to the OBE gross product originating estimates. Since the two sets of current-price esti-

[15] See Table A-vi below.

mates did not match precisely, the implicit deflator is subject to possible error. Moreover, the deflators for intermediate product purchases generally did not incorporate annually changing quantity weights, as is ideally desirable.[16]

There are greater possible sources of errors and inconsistencies with aggregate measures in the other industry real product estimates, for which the double-deflation method was not applied even in modified form. For some of these industries, base-period gross product was extrapolated by physical output series, or by the deflated value of gross output. This was the procedure used for fisheries, mining, trade, insurance, most transportation groups other than railroads, telephone and telegraph, and some of the service industries (private and public enterprises). The use of gross output extrapolators involves the assumption that the net-gross ratios did not change, or that, if they did, the changes are offsetting each other. The larger the net-gross ratio, the less the influence of changing ratios.

For most of the remaining industries, current gross product originating was directly deflated by price indexes, including average wage-salary (or, what amounts to the same thing, base period product was extrapolated by employment). Direct deflation of gross product by gross output price indexes involves the assumption that the ratios of prices received to prices paid have not changed. Actually, in the case of real estate, a rent index was averaged with prices of intermediate inputs (appropriately weighted) in order to approximate the implicit deflator. Average wage-salary indexes for deflators (or extrapolation of base-period gross product by employment) does not, of course, allow for productivity change. Fortunately, this procedure was confined to some of the service industries and a few minor residual industries such as agricultural services, brokerage, radio broadcasting, and TV. Once the "household and nonprofit institutions" sector is removed from the services industry grouping, the remaining proportion of the private services industries deflated by average pay is not large. Nevertheless, real product and productivity estimates in this grouping are subject to some downward bias.[17] Yet the industry aggregate is reasonably consistent with the final expenditure aggregate, since some of the service expenditure categories were likewise deflated by average compensation per full-time equivalent employee.

[16] See J. J. Gottsegen and R. C. Ziemer, "Comparison of Federal Reserve and OBE Measures of Real Manufacturing Output, 1947-64," *The Industrial Composition of Income and Product*, Studies in Income and Wealth, John W. Kendrick, ed., Volume Thirty-two, NBER, 1968.

[17] See *Production and Productivity in the Service Industries*, Victor R. Fuchs, ed., Studies in Income and Wealth, Volume Thirty-four, NBER, 1969.

Despite the possibilities for inconsistency between the sum of the real industry product estimates and the private domestic business aggregate obtained by the final expenditure approach, it will be recalled from Part I (and reference to Table A-4) that the statistical discrepancy between the two aggregates is not large and does not fluctuate markedly. This does not prove the accuracy of the industry estimates since there may be offsetting errors. But at least it means that the aggregate measure is close to a weighted average of the industry measures, and that industry-aggregate comparisons may be made on a statistically consistent basis. This was also true of the industry estimates used in the earlier volume, which were largely based on gross output extrapolators.[18]

Gross Output

Farming. Farming is the only industry group, as noted in the preceding section, in which the estimates of the real total value of output are completely consistent with the real gross product estimates. In this industry, therefore, the differences in movement between the estimates of gross output and real gross product (inclusive of capital consumption allowances, but not of intermediate product consumption) may be interpreted as reflecting changes in real purchases of intermediate products relative to gross (or net) output.

The relationships are shown for selected years in Table A-vi, which reproduces the OBE estimates drawn, in turn, from Department of Agriculture estimates rearranged in accordance with the OBE industry product concepts. We have modified the OBE concept only to the extent of including gross rents paid to nonfarm landlords in gross farm income and product, rather than excluding them along with intermediate purchases. This is consistent with our treatment of farm capital in terms of capital goods *used* in the sector.

In the table only the implicit deflator for total farm output is shown. Actually, the current dollar estimates were deflated in great detail: Cash receipts from farm marketings were deflated by indexes of prices received for all the various types of crops and livestock; farm products consumed directly in farm households were deflated by the corresponding prices received indexes; net change in farm inventories were obtained in constant prices by multiplying physical changes, by category, and base-period average prices; and the gross rental value of farm homes was deflated by a rent index. Similarly,

[18] See *Productivity Trends*, Appendix A, pp. 250-51.

TABLE A-vi

Farming: Total Output and Gross Product Originating in Current and Constant Prices, Selected Years, 1929-66

	1929	1948	1958	1966
		Billions of Current Dollars		
Total value of farm output	13.82	36.20	37.65	46.21
– Cost of intermediate products consumed[a]	3.32	11.20	15.14	19.38
Equals: Farm gross product	10.49	25.00	22.51	26.83
Factor costs, net of capital consumption[b] and business indirect taxes	9.09	22.66	18.60	23.12
Capital consumption allowances	0.86	1.85	3.79	4.95
Indirect business taxes less subsidies	0.54	0.49	0.11	–1.24
		Implicit Price Deflators		
Total value of farm output	58.1	115.0	100.0	108.1
Cost of intermediate products consumed	60.4	101.8	100.0	104.2
Farm gross product	57.0	122.0	100.0	110.9
		Billions of Constant Dollars		
Total value of farm output	23.8	31.5	37.6	42.7
– Cost of intermediate products consumed[a]	5.5	11.0	15.1	18.6
Equals: Farm gross product	18.4	20.5	22.5	24.2
		Per Cent in Terms of Constant Dollars		
Addendum:				
Ratio of real gross product to total output	77.3	65.1	59.8	56.7

Source: Rearrangement of OBE estimates contained in *The National Income and Product Accounts of the United States, 1929-1965, Statistical Tables,* Tables 1.17 and 1.18; and July 1968 *Survey of Current Business,* Tables 1.17 and 1.18

[a] Exclusive of gross rents paid to nonfarm landlords, which are included as part of gross product originating; inclusive of "other items," a small adjustment required in the OBE estimates to reconcile gross product estimates as total output less intermediate costs with the sum of factor costs and other charges against product.

[b] Except for a small amount of depreciation included in gross rents paid to nonfarm landlords.

the intermediate product purchases were broken down by type and deflated by the corresponding indexes of prices paid by farmers, based on Department of Agriculture estimates. The implicit deflators for total output and intermediate costs represent the quotients of the current and constant dollar aggregates. Real product is the difference between the real value of total output and real intermediate costs. The implicit deflator for gross farm product is obtained by dividing the constant dollar series into the current dollar estimates; it may also be viewed as a weighted average of the current dollar estimates, or as a weighted average of the implicit deflators for gross

output and intermediate purchases. Note also that gross farm product in current dollars derived as the difference between the total value of output and intermediate costs equals the sum of factor costs, capital consumption allowances, and indirect business taxes less subsidies.

It can be seen in Table A-vi that the ratio of intermediate costs to the total value of farm output in real terms rose from about 35 per cent in 1948 to 44 per cent in 1966. This continued the rising trend evident in prior decades, reflecting the transfers of various activities from the farm to nonfarm sectors, and the increasing use of various nonfarm inputs required to operate tractors, farm trucks, et cetera.

This trend is reflected, of course, in a significantly smaller rate of increase in real farm product than in total gross output. The latter measure should really be related not only to factor inputs but to total input inclusive of intermediate inputs as well, which would reduce the apparent rate of productivity advance. Generally, we use gross output measures as a proxy for real product measures, and so relate only to factor inputs. In the case of farming, however, it is clear that gross output has a persistent upward bias as a proxy for real product and cannot be so interpreted.

In the analyses, we used the real product estimates and the corresponding productivity estimates with all industry groups for which both sets of output estimates are available. The gross output estimates are presented to serve as supplementary information and to continue the gross output series presented in *Productivity Trends*.

Mining. The gross output index numbers for the mining group, and the four component industries, are the Census Bureau-Federal Reserve Board benchmark indexes for 1947, 1954, and 1958, interpolated and extrapolated by the corresponding FRB annual production indexes for the corresponding groupings. As described in greater detail below for manufacturing, the Census-FRB benchmark indexes represent the value of production, deflated by unit value or price indexes in terms of five-digit product classes. The 1947-54 indexes were combined using 1954 unit value weights, while the 1954-58 indexes employ 1958 unit value weights, which is roughly consistent with our general weighting procedure. The crude petroleum and natural gas production index includes the physical volume of oil and gas drilling activity, which is consistent with our earlier industry definition and with the coverage of the input measures.

The benchmark index numbers for 1963 relative to 1958 were not available at the time of writing, but we are informed that the changes are fairly

close to those indicated by the annual FRB indexes, according to preliminary results.

The gross production index shows closely similar movements to the real gross product measure for the mining group. This is not surprising when it is realized that OBE extrapolated base period gross product originating in the component industries forward, and back to 1947, from 1958 by the FRB annual indexes. The slight deviations in movement are due to the following factors. The component FRB mining industry indexes were not yet tied into the 1958 and 1963 benchmark indexes. This means that the 1954-58 movements of the industry indexes, and thus of the group index, differ somewhat from our gross output indexes. Specifically, the real product measures for metal and nonmetallic mining rise a bit less. On balance, the group gross output index falls by 1.0 percentage point relative to the real product measure during 1948-54, rises by 1.5 percentage point in 1954-58, and shows virtually the same movement thereafter. Some small part of the difference is due to the different weighting procedure implicit in the group real product measure. The real gross output index is the more up-to-date measure. Since the real product measures are not published for the four industry components, we use the gross output indexes exclusively for these industries.

The 1957 SIC combined anthracite and bituminous coal mining into one two-digit industry. In *Productivity Trends* we showed the components separately; in the present study our measures relate to the combined coal industry.

Manufacturing. The manufacturing gross output indexes for total manufacturing and its components—durables and nondurables—and the twenty-one two-digit groups are based on the Census-FRB benchmark production indexes for 1947, 1954, 1958, and 1963, interpolated and extrapolated to 1966 by the FRB indexes of manufacturing production.[19] In summarizing the construction of the benchmark indexes, we shall refer chiefly to the indexes for 1954, 1958, and 1963, which differ in a few respects from the earlier indexes in ways that will be indicated.

In all the benchmark indexes, the detailed quantity and value data for manufacturing products (published in Tables 6 of Volume II of each manufacturing Census) are basic. Weighted indexes of the quantity of products are not directly used, however. Rather, for the 1954-58 and 1958-63 indexes, the

[19] See, particularly, the *Census of Manufactures, 1963,* Bureau of the Census, Vol. IV, *Indexes of Production,* 1968. The indexes through 1954 are described in *Productivity Trends.*

value of output of every industry was deflated in five-digit detail, using the breakdowns of industry shipments, adjusted for inventory change, published in Table 5B of Census Volume II. Thus, secondary products were more appropriately deflated than in earlier benchmark calculations, in which they were implicitly deflated by the unit values of the primary products of each industry.

The deflators were based primarily on unit values, derived as quotients of the value and quantity data available for about 5,000 products in more than 1,000 Census seven-digit product lines. The unit values give accurate measures of price change to the extent that changes in product mixes at the seven-digit level were not significant, or did not affect unit value, on balance. The unit value indexes were reviewed, and in some cases rejected, if external evidence or criteria indicated that their movements were significantly distorted. The Census unit value indexes were supplemented by the BLS wholesale price index series, and to some extent by price or unit value data from other sources, such as the Tariff Commission and Bureau of Mines.

Indexes of the deflated value of production were weighted by value-added at the four-digit industry level up to 1954; since 1954, value-added weights were applied at the five-digit product class level. The more detailed weighting makes little difference in the movements of the two-digit industry indexes. The choice of weight base or bases does make a difference in movements, however, as a result of the significant negative correlation between relative changes in prices or unit value-added and in quantities. For example, the total manufacturing index increased by a 0.6 percentage point a year faster from 1954 to 1958 with 1958 weights than with 1954 weights, and by a 0.2 percentage point a year less from 1958 to 1963 with 1958 weights than with 1963 weights.[20] For the period 1954-66 as a whole, our use of 1958 price and unit value weights would result in little difference in movement in comparison with the use of average 1954-66 weights.

Finally, we must note the differences in movement of the Census-FRB gross production indexes and the OBE real product measures and consider the chief factors that could account for them. The gross output index for total manufacturing rises by about 8 per cent more than the real product estimates between 1948 and 1960, and thereafter shows little difference in trend. The relative increase is somewhat greater in nondurables than in durables. Although OBE does not regularly publish its estimates of real product by two-digit industries, they were published for the period 1947-64 as part of an

[20] Ibid., Table B, p. 4.

article analyzing the differences between the OBE and FRB indexes.[21] The relative increase in the gross output indexes is evident in all industries but tobacco products, fabricated metal products, and petroleum refining. The differences in annual changes were frequently significant. This is believed to reflect to an important extent the sensitivity of real product estimates to differential changes in the output and input deflators.[22] In fact, even if real product estimates by two-digit industries were available for use, we might well have chosen to use the gross output indexes anyway because of their lesser short-term instability.

There are several reasons for the differences in trend between the OBE real product and the Census-FRB gross output indexes. The first is conceptual. As noted earlier, the OBE estimates are approximations of true net output measures, while the Census-FRB indexes, in effect, extrapolate base-period value-added by gross output measures at the five-digit level. To the extent that real intermediate costs have risen in relation to gross output in these industries, real product would rise less than gross output, as in the case of agriculture.

Yet it is doubtful whether this is the main explanation of the divergence in trend between the two measures, since there are a number of statistical and methodological differences between the series. In the first place, OBE relied primarily on BLS wholesale price indexes as deflators, while Census-FRB relied primarily on a larger range of unit value indexes. Since the latter set of indexes tended to show a lesser increase over the period, this appears to be a major factor explaining the greater increase in the Census-FRB measures.[23] The 1954 value-added weights used for the Census-FRB indexes underlying our measures result in a somewhat higher rate of increase for 1948-54 than would the 1958 weight base employed by OBE throughout. A further small difference arises from the fact that the Census-FRB weights are gross value-added while the OBE weights are net value-added, inclusive of excise taxes and depreciation.

The possibilities of divergence between the two measures in the annual changes and the 1963-66 trend are even greater than in the trends between Census benchmarks. The OBE estimates, based on the Census annual survey of manufactures, are subject to sampling errors in the value estimates as well as to cyclical biases in the price deflators. The implicit deflator for gross

[21] *The Industrial Composition of Income and Product,* Studies in Income and Wealth, Vol. 32, pp. 225-346.

[22] Ibid., Comment by Frank Garfield on the Gottsegen-Ziemer paper, pp. 367-70.

[23] Ibid., Comment by Vivian Spencer on the Gottsegen-Ziemer paper, pp. 355-56.

product is particularly sensitive to errors in the component deflators since it is a weighted difference between the output and intermediate input deflators. The FRB index by which we have interpolated and extrapolated the benchmark indexes relied on quantity series and proxies for output, particularly productivity-adjusted man-hours, for about half the series. Although the proxies are based on careful study of their relationship to actual output measures for benchmark years, it is obvious that errors will occur and may cumulate in the extrapolation period. They may be particularly significant in some of the two-digit industries, but tend to offset each other in the broader group measures. Fortunately, our estimates extend only three years beyond the latest (1963) benchmark, so the biases should be limited.

Transportation. Gross output for the transportation industry as a whole is based on estimates of gross output in each of the covered sectors described below, weighted by base-period (1958) GNP originating. In practice the estimates were made by taking the estimates prepared by the Office of Business Economics of average current dollar GNP originating in 1958 for each industry and extrapolating by the appropriate output indexes for the period 1948-66. The GNP originating in the covered segment was adjusted to include a residual sector that comprises transportation services not covered in the individual industries for which estimates could be made. The adjustment factor was based on a ratio of persons engaged in the covered industries to OBE estimates of persons engaged for the whole transportation industry. Estimated real GNP was divided by these adjustment ratios annually for the years 1948-66 in order to derive an estimate for real GNP for the transportation industry, including the residual sector. This procedure implied that GNP per person engaged in the uncovered sector showed the same movements as that in the covered sector. The uncovered sector comprised 21.9 per cent of industry GNP in 1948 and 23.5 per cent in 1966.

A separate series of real GNP originating in the nonrailroad sector was obtained by subtracting real GNP originating in railroads from total real GNP. Both series were transformed into output indexes using 1958 as the comparison base.

Except for the use of new weighting and comparison bases, the railway output index constructed for this study is based on the same procedures as those described in *Productivity Trends*. The index shown in Table A-60 covers all phases of railroad passenger and freight operations. It is based on statistics compiled by the Interstate Commerce Commission and published under the title *Statistics of Railways in the United States* for the years

1948-53 and as *Transport Statistics in the United States* from 1954 to the present.

The index of freight output was based on revenue ton-miles weighted by average revenue per ton-mile in cents. An output index was prepared for each of the three classes of line-haul railroads. The output of Class I, II, and III line-haul railroads omits a small fraction of total railway output, that of switching and terminal companies and of the Railway Express Company. In order to account for this segment of coverage, adjustment based on total operating revenues to operating revenues of the covered segment was calculated for each year of the period. The adjustment ratio fluctuated only narrowly between 1.045 and 1.052.

In 1956, the three-division classification of line-haul railroads was changed. Before that date, Class I line-haul railroads were those with annual operating revenues over $1,000,000, Class II, between $100,000 and $1,000,000, and Class III, below $100,000. The 1956 reclassification eliminated Class III and redefined Class I as railroads having $3,000,000 or over in annual operating revenues and Class II as having under $3,000,000. Because of the relatively small size of Class III, Classes II and III were combined for the years 1953-55 in order to assure weighting-base comparability.

For the period 1948-53, we calculated weights for each of the three classes and used the average of 1948 and 1953 as a weight base. The separately weighted output indexes were then combined into an aggregate and linked in 1953 to the aggregate employing average 1958 weights. The index for the entire period 1948-66 was expressed on the comparison base of 1958=100.

The ICC transportation statistics give passenger-miles for Class I railroads in commutation, coaches, and parlor and sleeping cars. For Class II and Class III and for the Pullman Company, only the total number of revenue passenger-miles are given. Each of the available divisions of passenger traffic was weighted separately by average revenue per passenger per mile using the same weight bases as in freight traffic. The aggregate passenger output is the sum of the individual weighted outputs on a comparison base of 1958=100. The 1956 change in the classification scheme was treated in the same manner as it was for freight output.

Total output was obtained by weighting the freight and passenger output indexes together by their proportionate shares in total operating revenues in the two base periods, linking in 1953, and using the 1958 comparison base throughout.

For air transportation, the index of output which appears in Table A-68 is

the BLS composite index based on the quantities of passenger and cargo services combined with unit revenue weights for the average of the years 1957-59. This output index is separated into eight categories. The various outputs are domestic and international territorial operations (measured by passenger-miles), freight ton-miles, express ton-miles, and U.S. and foreign mail ton-miles for both scheduled and nonscheduled services. Unit revenue weights for the outputs are generally based on revenue derived from scheduled services only.

The major source of the output data is the Civil Aeronautics Board (CAB). Data collected from the different carriers were published in 1963 in a *Handbook of Airline Statistics*. A CAB monthly publication, *Air Carrier Traffic Statistics*, is another important source for output data.

For pipeline transportation, the ICC reports contain data on barrel-miles of crude and refined oils having trunkline movement.[24] These were converted to ton-miles, using Barger's conversion factors: one barrel crude = 0.15 ton; one barrel refined = 0.13 ton.[25] Oil movement through the gathering lines operated by interstate carriers is not reported. The trunkline estimates were adjusted by dividing by the ratio of depreciation and amortization for trunk-pipelines to the total for all lines. This ratio rose gradually from 81.5 per cent in 1948 to over 87 per cent in 1966. Thus, total estimated output rises less rapidly than that based on trunkline data only, and is consistent with the employment data. No such adjustment was made in the earlier output and productivity estimates, which, as was noted, may have resulted in some upward bias on this account.

Water transportation output (Table A-67) is the sum of the weighted outputs of freight traffic and of international and other passenger traffic, as shown in Table A-vii. Relative 1957-59 weights were calculated by revising the 1929 weights used in *Productivity Trends* (Table G-5) to reflect the relative changes in volume since then.

Freight output statistics were gathered for five types of traffic: coastwise and intercoastal; internal (inland); noncontinguous; domestic Great Lakes; and international.[26] These data have been tied to the estimates in *Producti-*

[24] See Interstate Commerce Commission, *Annual Report on the Statistics of Railways in the United States*, Tables 175-76, for the period 1948-53; from 1954 onward, ICC's *Transport Statistics in the United States, Part 6, Oil Pipe Lines*.

[25] See Harold Barger, *The Transportation Industries, 1889-1946: A Study of Output, Employment, and Productivity*, New York, National Bureau of Economic Research, 1951, p. 251, footnote C.

[26] Ibid., p. 17, note C.

TABLE A-vii

Water Transportation,
Percentage Weights by Category, 1957-59

Freight	86.6
International	26.8
Great Lakes	5.5
Internal	20.5
Noncontiguous	9.2
Coastwise and intercoastal	24.6
Passenger	13.4
International	6.2
Other[a]	7.2

[a] Includes passenger traffic on ferry, Great Lakes, and other inland vessels, also on coastwise, intercoastal, and noncontiguous vessels.

vity Trends. Unit revenue weights from Barger (Table 30, p. 128) were used throughout.

Ton-mile figures for coastwise and intercoastal traffic are not available prior to 1955. Therefore, the period 1948-54 was extrapolated by linking with the *Productivity Trends* data on the basis of tons of freight carried. For 1955-61, ton-mile statistics published in ICC Statement 6501 were used, and for the remainder of the period, U.S. Corps of Army Engineers ton-mile data. Two adjustments are necessary to make the series internally consistent. First, a comparison of our estimate for the year 1955 with the ICC ton-mile data shows that the level of the former is somewhat higher than the ICC figures for that year. The ratio of the ICC figure to our estimate in 1955 was used to adjust the level of our estimates for 1948-54 to that of the ton-mile data. Second, the Army ton-mile data published since 1961 include noncontiguous traffic. In order to maintain comparability with the data prior to 1961, noncontiguous traffic as published in ICC Statement 6501 was subtracted from the Army coastwise statistics.

Estimates for noncontiguous traffic are an extrapolation of the previous data on the basis of short tons of freight carried.

The series for internal waterways is a departure from the earlier Kendrick-Barger output statistics. The basic series used by Kendrick and Barger overstates the level of output because the Army statistics published before 1961

include a certain amount of foreign flag traffic on internal waterways. Beginning in 1961 the ton-mile data published in the U.S. Department of Commerce publication *Waterborne Commerce of the United States* (Supplement 2 to Part 5, National Summaries) are given by type of carrier and exclude foreign flag vessels. Private information from the Corps of Engineers established the fact that the portion of foreign flag traffic included in the inland traffic statistics has been about the same since the end of World War II. Therefore, the ratio of new data in 1961 to the old in 1961 was applied to the statistics between 1948 and 1960 in order to adjust for the inclusion of foreign flag traffic prior to 1961.

The level of output for Great Lakes traffic used in this study is below that of the series used in *Productivity Trends* because domestic Great Lakes traffic data were available, while the earlier series includes foreign as well as domestic traffic.

Because there are no ton-mile figures available for international freight traffic of U.S. flag vessels, we extended the earlier Barger-Kendrick ton-mile output figures on the basis of short tons of freight carried by U.S. flag vessels.

The passenger output sector of the water transportation industry suffers from a shortage of usable statistical information. The primary source for the Barger study was the Corps of Engineers' *Annual Report*, Part 2. All of the information published by the Corps on passengers carried in the various noninternational modes of water transportation was discontinued in 1947 because of incomplete information. As far as we have been able to ascertain, no new studies concerning miles traveled by various types of passengers have been made since Barger published his findings. As a result our estimates are exact extensions of the methods used in *Productivity Trends*.

Passenger-mile estimates for international travel were prepared on the basis of the number of passengers arriving in and departing from U.S. ports as published in the *Annual Report of the Immigration and Naturalization Service* (Tables 31 and 32), linked up with the earlier Kendrick-Barger passenger-mile estimates.

The "other" category includes coastwise, internal, and ferry traffic. Because the Corps of Engineers stopped publication of passenger data in these categories, estimates were extended on the basis of vessel tonnages engaged in domestic trade.

The local transit industry includes electric railways and local bus lines, as described below. It presents a more accurate measure of productivity than either of the component parts—electric railways and local buses. This is so because it was necessary to apply average hours in the whole industry to

employment in each of the individual sectors to obtain man-hour figures, and split output estimates between public and private sectors based on total industry data.

The separate output indexes were combined on the basis of relative revenue weights. These weights reflect the relative contribution of electric railways and local buses to total revenue. For the years 1948-53 electric railways accounted for 43.5 per cent of total revenue, and local buses provided the remainder. In the period 1957-59 the importance of local bus operations increased, accounting for 65.6 per cent of total revenue, while electric railways produced 34.4 per cent of total revenue. It must be noted that the roles of electric railways and local buses have almost reversed themselves since 1939, the weight base year used by Barger in *The Transportation Industries* (Tables 3 and 4). At that time electric railways were the dominant sector in the industry.

The combined output index shown in Table A-64 was placed on a 1958 comparison basis. Despite the declining importance of electric railways relative to local bus lines, the irregularity of the final output for the former transmitted itself to some extent to the index of output for the local transit group as a whole.

The local bus lines portion of the local transit industry is composed of companies primarily engaged in operating street and suburban passenger bus lines, within the confines of a single municipality, contiguous municipalities, or a municipality and its suburban areas (see *Productivity Trends*, p. 516). Again, we are considering only private companies in calculating the productivity indexes.

The output index is based on the number of revenue passengers carried by private bus lines. A ratio of private employment to total employment for the local transit group applied to the number of revenue passengers carried on public plus private local bus lines provides an estimate of output for the private sector of local bus lines. The series of private employment for the local transit industry is the same one described in the local transit section. The series of total employment (private and public) can be obtained from the American Transit Association's *Transit Fact Book*. This is also the source of the number of revenue passengers carried on private and public bus lines. This extrapolation was necessary for the years 1954-66 only. For the period prior to 1954 we used the basic data given in *Productivity Trends*. The output estimates were then weighted by unit revenues in the two weight periods (1948-53 and 1957-59) and an index was calculated and put on a 1958 comparison base.

The electric railway portion of the local transit industry includes local street and interurban railway systems, elevated or subway lines, and trolley buses. It does not include the electrified portion of steam railroads. Output and productivity measures were confined to the private sector.

The traffic output indexes for the 1948-66 period are based on a weighted aggregate of revenue passengers and freight car-miles on electric railways. The traffic indexes of the 1948-53 period are derived in the same manner as those appearing in *Productivity Trends*. Differences between the former estimates and those shown here resulted from a change in the weight base from 1939 to 1948-53 and 1958, and a change in the comparison base from 1929 to 1958. For the remainder of the period 1953-66 a new method was used to estimate the number of revenue passengers carried.

For freight output (car-miles) the ICC was the primary source of data: for the 1948-53 period, *Statistics of Railways in the United States,* and for the 1953-66 period, *Transport Statistics in the U.S.*, Part 4, *Electric Railways.* A weighted output was calculated by applying a unit revenue weight (freight revenue per car-mile) to car-mile data. The irregular behavior of output as reported by the ICC can be explained in part by the fact that the number of carriers reporting to the ICC between 1956 and 1960 decreased from forty-one to twenty-five. This decrease is a result of two factors. On the one hand, some carriers have been reclassified as Class II line-haul railroads. Because freight output is relatively more important than passenger output, the total output index was affected by the irregular behavior of the freight sector. This behavior can also be noted in *Productivity Trends,* Table G-V, for the 1948-53 period.

For passenger output the basic series is the number of revenue passengers carried. The *Transit Fact Book* is the major source of data. These include revenue passengers carried on both private and municipally owned systems. The number of revenue passengers carried for the years 1948-53 on privately owned systems was derived on the basis of the method presented by Ulmer,[27] which is based on unpublished data from the American Transit Association. It was not feasible to obtain the data for this study after 1953. Therefore, for the period 1954-66 the number of revenue passengers carried was adjusted by the ratio of employment in the private sector to employment in the whole sector, applied to the number of revenue passengers carried on electric railways as reported by the ATA. According to this extrapolation,

[27] Melville J. Ulmer, *Capital in Transportation, Communications, and Public Utilities: Its Formation and Financing,* Princeton University Press for NBER, 1960, Table I-26.

output per employee in the private sector moved in the same relative fashion as did output in the whole sector. Freight and passenger outputs were weighted by 1948-53 and 1958 unit revenues and then combined.

The estimates of productivity in intercity motor carriers of passengers (bus), given in Table A-65, cover all classes rather than Class I alone. Following the method in *Productivity Trends* (pp. 519-21), revenue passenger-miles were used as the output measure of intercity bus lines. This was obtained from *Bus Facts* (33rd edition, 1965, p. 6). Figures for the 1957-64 period also appear in the *Statistical Abstract* (1965, p. 559, Table 780). The revenue passenger-mile figures for 1965-66 were supplied by the National Association of Motor Bus Owners.

Output and productivity estimates for intercity trucking shown in Table A-66 were based on Class I and II intercity carriers. For the period 1950-66, ton-mile data provided by the American Trucking Association's *American Trucking Trends* were used as output. First, the number of carriers, Class I and II, is multiplied by average power units operated per carrier. This result is multiplied by ton-miles per power unit to get total ton-miles. Secondly, figures for 1948 and 1949 are extrapolated from 1950 by the intercity tonnage index, Classes I and II, in the American Trucking Association's *Intercity Truck Tonnage*, (1965, p. 4). This extrapolation is necessary as separate figures on Class II and III are not available prior to 1950.

For the transportation segment as a whole, gross output rose by about 10 per cent more than real product between 1948 and 1966. This was due to a relatively large increase in the gross-net ratio in the nonrailway transport segment more than offsetting a modest decline in the gross-net ratio in the railway industry. Based on independent estimates by the author, savings of more than 4 per cent appear to have been achieved in the consumption of fuels and other intermediate inputs per unit of output by the railroads over the period. In the nonrailroad segment, the 20 per cent increase in gross output relative to real product may largely reflect an underestimate by OBE of the growth in real product. For example, the OBE estimate of the increase in airlines real product falls significantly below the increase in the gross output estimates of BLS used in this study, despite the fact that the airlines also achieved some savings in the use of fuels and other intermediate inputs per unit of output. But in the face of the inadequacy of basic production data for a large portion of nonrailroad transportation, we cannot definitely conclude that the gross output measures are superior to the real product estimates. More and better data are needed to improve both sets of estimates.

Electric and Gas Utilities. For this industry we employ the output index

prepared by the Bureau of Labor Statistics for its productivity studies.[28] The component electricity and gas output measures are very similar to the indexes prepared for *Productivity Trends* (Appendix H).

Electricity output is measured in terms of kilowatt-hours sold, by class of service: residential, commercial, and industrial, and other ultimate consumers for privately owned class A and B electric utilities and for Rural Electrification Administration borrowers (by type of service beginning in 1957).

The basic sources are the Federal Power Commission's *Statistics of Electric Utilities in the United States, Privately Owned,* and REA's *Annual Statistical Reports*. Weights are the average 1957-59 revenue per KWH for each class of service.

Gas production (sales) is measured in terms of therms, by type of service—residential, commercial, industrial, and other—for privately owned gas utilities and pipelines. Sales cover natural, manufactured, mixed, and liquified petroleum gas. The source of the basic data is the American Gas Association. Average 1957-59 revenues per therm, by class of service, are used as weights.

The separate electric and gas output indexes were combined, using a harmonic mean, with the current employment weights. It should be noted that the products not covered by the combined index amounted to about 3.5 per cent in 1947 and to about 1 per cent in 1961.

The BLS gross output index for electric and gas utilities rose by almost 20 per cent more than the OBE estimates of real gross product originating in the electric, gas, and sanitary services group. Presumably, this reflects a much lower rate of output growth in the sanitary and other local utility services which are not included in the BLS measure. Part of the difference could be due to different methodology, since OBE deflated sales to each class of customer by corresponding wholesale and consumer price indexes. OBE also deflated costs of fuels and certain other intermediate purchases to deduct from gross output, but the double-deflation approach would have worked in the opposite direction, since fuel requirements per unit of output declined over the period. Differences in the weighting procedures to combine the two component industry indexes may have accounted for a small part of the difference in trends.

Industry Composites.

It is apparent from the foregoing industry discussion that the gross output indexes rose somewhat faster over the period 1948-66 than the real product

[28] *Indexes of Output per Man-Hour, Gas and Electric Utilities Industry, 1932-62,* U.S. Department of Labor, April 1964. These estimates are updated annually by the BLS.

measures in the groups for which we have both. Weighted averages for the two sets of indexes for the relevant nonfarm industry segments—mining, manufacturing, transportation, communication and public utilities, and trade—indicate that the composite gross output index rose by about 9 per cent more over the eighteen-year period than the real product composite. As implied earlier, this discrepancy is probably the result of different sources and methods underlying the two sets of estimates rather than of an increase in real intermediate costs relative to gross output.

In the text, we discuss the relative movements of output and productivity in thirty-two industry groups for which we have capital, total input, and total productivity indexes.[29] In this collection of industries, we use gross output and derived total factor productivity indexes for twenty-seven of the industries; for the others—railroads, communication, electric, gas, and sanitary services, wholesale and retail trade—we use real product indexes. This composite rises by 113 per cent between 1948 and 1966, compared with a 103 per cent increase using real product indexes for all of the corresponding groups. The average annual percentage rates of change for the two composites are 4.3 and 4.0, respectively. Thus, it should be borne in mind in interpreting the behavior of the thirty-two industries that their composite output rises by 0.3 per cent a year more than the composite that forms a major portion of the real product index for the private domestic business economy as a whole. It so happens that the latter index also rose by 103 per cent, or 4.0 per cent a year, over the period. This means that the industries for which we do not have capital estimates—agricultural service, forestry and fisheries, certain nonrail transportation groups, finance and services, including government enterprises but excluding households and nonprofit institutions—grew at about the same rate as the industries for which capital estimates could be prepared.

Labor Input

In Part I it was pointed out that the persons-engaged, man-hours, and labor-input (weighted man-hours) series for the economy were built up from estimates for the component two-digit industries, with subtotals for the one-digit industry groups. There we summarized the basic sources and methods used to obtain the industry and aggregate estimates. For more detailed descriptions, the labor sections of the appendixes in *Productivity*

[29] Two groups which are complete segments—farming and contract construction—are omitted.

TABLE A-viii

Private Domestic Business Economy: Persons Engaged, Man-Hours, and Labor Compensation by Industry, 1958

Industry Group	Persons Engaged (Thousands)	Man-Hours (Millions)	Labor Compensation (Millions $)	Labor Compensation (Percentage Distribution)
Agriculture, forestry, fisheries	6,085	13,249	11,702	4.88
Farming	5,777	12,579	10,614	4.43
Agricultural service, forestry, fisheries	308	670	1,088	0.45
Mining	788	1,609	4,506	1.88
Metal	95	191	570	0.24
Coal	226	388	1,275	0.53
Oil and gas	344	753	2,013	0.84
Nonmetal	123	277	648	0.27
Contract construction	3,586	7,082	17,535	7.32
Manufacturing	16,308	31,747	88,162	36.77
Nondurables	7,230	13,987	35,433	14.78
Foods	1,576	3,166	7,681	3.21
Beverages	214	419	1,219	0.51
Tobacco	93	179	385	0.16
Textiles	925	1,790	3,329	1.39
Apparel	1,186	2,111	4,013	1.67
Paper	559	1,164	3,099	1.29
Printing, publishing	947	1,781	5,240	2.19
Chemicals	798	1,599	5,258	2.19
Petroleum refining	227	444	1,968	0.82
Rubber products	347	681	1,941	0.81
Leather products	358	653	1,300	0.54
Durables	9,078	17,760	52,729	21.99
Lumber products	711	1,350	2,664	1.11
Furniture	386	759	1,693	0.71
Stone, clay, glass products	580	1,150	3,102	1.29
Primary metals	1,161	2,195	7,553	3.15
Fabricated metals	1,099	2,168	6,265	2.61
Machinery except electric	1,407	2,746	8,535	3.56
Electric machinery	1,234	2,426	7,075	2.95
Transportation equipment and ordnance	1,766	3,539	11,996	5.00
Instruments	329	648	2,002	0.84
Miscellaneous	405	779	1,844	0.77
Transportation	2,554	5,804	15,609	6.51
Railroads	956	1,946	6,103	2.55
Nonrail	1,598	3,858	9,506	3.96
Local, suburban, and highway passenger transportation	313	728	1,492	0.62
Motor freight transportation and warehousing	803	2,097	4,994	2.08

TABLE A-viii (concluded)

Industry Group	Persons Engaged (Thousands)	Man-Hours (Millions)	Labor Compensation (Millions $)	Labor Compensation (Percentage Distribution)
Water transportation	213	450	1,342	0.56
Air transportation	169	360	1,085	0.45
Pipeline transportation	25	53	172	0.07
Transportation services	75	170	421	0.18
Communication and public utilities	1,483	3,066	8,308	3.47
Communication	854	1,728	4,477	1.87
Telephone and telegraph	774	1,552	3,877	1.62
Radio broadcasting and television	80	176	600	0.25
Electric, gas, and sanitary services	629	1,338	3,831	1.60
Trade	12,117	28,143	52,814	22.03
Wholesale	2,992	6,639	17,572	7.33
Retail	9,125	21,504	35,242	14.70
Finance, insurance, real estate	2,675	5,521	13,265	5.53
Finance and insurance	1,962	4,049	10,466	4.36
Real estate	713	1,472	2,799	1.17
Services (excluding households and nonprofit institutions, including government enterprises)	6,492	13,716	27,834	11.61
Services	5,566	11,929	23,064	9.62
Government enterprises	926	1,787	4,770	1.99
Federal	600	1,094	3,250	1.36
State and local	326	693	1,520	0.63
Private domestic business economy	52,088	109,937	239,735	100.00

Trends may be consulted, since the same sources and methodology are used in the present work. In this section, therefore, it is only necessary to refer to a few supplementary matters relevant to the industry and group estimates.

First, since the tables referred to in Part I give estimates for only the broad industry segments of the economy, in Table A-viii above we present estimates of persons engaged, man-hours, and labor compensation by two- or three-digit industries within the major industrial divisions of the private domestic business economy for the base year 1958. By applying the index numbers for persons engaged and man-hours from the later industry tables to the 1958 figures, the reader can derive annual estimates for the period 1948-66 and compute average hours worked per year as a quotient if desired. It will be recalled that the persons-engaged estimates are based on the OBE series,

raised to include unpaid family workers where significant. The man-hours and labor compensation estimates also allow for unpaid family workers as well as for proprietors. The labor compensation estimates are relevant to the derivation of base-period relative weights used to combine man-hours when aggregating to obtain labor input by industry group.

Table A-ix compares the movement of weighted and unweighted man-hours by industry segment between 1948 and 1966. The table makes the point noted in Part I that weighted man-hours (labor input) in the private domestic business economy as a whole increased by 7.2 per cent more than straight man-hours. This is due entirely to the farm-nonfarm shift, since within the nonfarm economy weighted and unweighted man-hours show virtually the same increase. Table A-ix indicates that this is the result of offsetting shift effects among the several industry groups. Internal weights result in a larger increase in labor input than in man-hours in most groups. But in mining and transportation the shift effect works in the opposite direction. In the latter group, the relative decline in the highly paid railroad industry is the reason. In the mining group the relative decline in the highly paid coal mining industry is the chief factor. Otherwise, the tendency has been for workers to shift towards higher-paying industries.

In concluding this section, we stress that the labor estimates are consistent with the gross product estimates, on the basis of an individual industry as well as the economy as a whole. This is because the employment data and the labor compensation portion of the industry product estimates are drawn from the same sources, chiefly social security records. The reader should be reminded, however, that the average hours estimates by industry are not entirely consistent. Whereas the bulk of these estimates are drawn from Census sources and represent hours worked, in several industries—notably wholesale and retail trade—we relied on BLS estimates, which represent hours paid for and decline somewhat less than hours worked.

Real Capital Stock and Input

The estimates of real gross and net capital stocks for the various industries come from several different sources, but are based on broadly consistent methodology. They are available for all the industry groups except finance and services. After summarizing the underlying sources and methods, we shall compare the sum of the industry estimates for the private domestic nonfarm business economy, and assess the residual for reasonableness. The methods whereby the group capital estimates were combined with each other to obtain

TABLE A-ix

Private Domestic Business Economy: Man-Hours, Weighted Man-Hours, and Shift Effect by Industry Group

Industry Group[a]	Index Numbers, 1966 (1948=100)		
	Man-Hours (1)	Weighted Man-Hours (2)	Shift Effect (Col. 2)÷(Col. 1) (3)
Mining	69.3	64.8	0.935
Manufacturing	123.9	126.8	1.023
Nondurables	108.6	110.8	1.020
Durables	136.7	139.0	1.017
Transportation	82.5	78.9	0.956
Nonrail	124.2	126.6	1.019
Communication and public utilities	124.0	124.9	1.007
Communication	128.2	129.9	1.013
Trade	122.2	123.5	1.011
Finance	162.5	166.8	1.026
Services (excluding households and nonprofit institutions, including government enterprises)	149.8	149.8	1.000
Private domestic business economy	109.5	117.4	1.072
Nonfarm	123.7	123.5	0.998

[a] Excludes groups such as contract construction, for which internal weights were not applied because of lack of breakdowns.

aggregates for the private domestic business economy were described in Part I; the only groups where internal industry weights were used to combine the capital estimates were mining and manufacturing. The final sections describe the weighting system by which the capital and labor input measures were combined for component industries, and introduce the productivity summary tables beginning with A-22.

Farming. The sources and methods used in estimating the real capital stock employed in farming were described in Part I. To summarize briefly, we used the OBE estimates of real structures and equipment based on Bulletin F

service lives less 15 per cent, with the Winfrey S-3 retirement curve used for estimating gross stock and straight-line depreciation rates used for calculating net stock. The farm inventory estimates are also from OBE, which multiplied physical units of various types of crops and livestock on hand at the end of each period by average base-period prices. For agricultural land, we multiplied Department of Agriculture estimates of acreage for ten regions by the estimated 1958 values per acre. All year-end estimates were adjusted to annual averages.

Mining. Our basic procedure for this group was to deflate the corporate book-value data given in *Statistics of Income* for the four component industries, adjusted where necessary for continuity and raised to total industry coverage.[30] The Internal Revenue Service data were available separately for gross and net depreciable and depletable assets, land, and inventories, and the corresponding sales data were also taken as a basis for the coverage adjustments. The data were available for each of the four industry groups, except for the period 1957-62, when anthracite coal was combined with nonmetallic mining instead of with bituminous coal. For this period, 1957 data for anthracite coal alone were extrapolated by data for "other nonmetallic mining excluding dimension stone, including anthracite," and then subtracted from nonmetallic mining and quarrying and added back into the coal group. Also, it was necessary to interpolate linearly betwen 1961 and 1963 to obtain estimates for land and depletable capital, since only depreciable assets data were provided for 1962.

End-of-year balance sheet data were transformed to mid-year ones by two-year moving averages. The corporate assets data were adjusted to total coverage by multiplying by the 1953-64 ratio of Bureau of Mines data on the value of total mineral production to the IRS corporate sales data, by industry. The average ratios for the period are as follows: metal mining, 1.0618; coal mining, 0.9605; crude petroleum and natural gas, 2.1032; and nonmetallic mining and quarrying, 2.3163.

The fixed capital estimates were deflated by Daniel Creamer's implicit price deflator for the net book value of manufacturing capital (see next section). This deflator was extrapolated back to 1948 by the OBE implicit deflator for private domestic nonresidential investment, using the following weighting pattern: given year, t, X 5; t-1 X 4; t-2 X 3; t-3 X 2; and t-4 X 1.

30 We generally follow the method described in D. Creamer, S. Dobrovolsky, and I. Borenstein, *Capital in Manufacturing and Mining: Its Formation and Financing*, New York, NBER, 1960, Appendix B.

Inventories were deflated by a composite of two indexes. For each mining industry, a unit value of output index was weighted 0.75. The other component was the BLS wholesale price index for industrial commodities, weighted 0.25.

In the case of crude petroleum and natural gas, we extrapolated the 1953 estimate to 1948 by the series presented in *Productivity Trends*, Appendix C, and interpolated annually by the series obtained as described above. The capital estimates for the other industries were obtained directly for the period 1948-53 by the sources and methods described above. The estimates for the mining group are the weighted sum of the estimates for the four components; the relative weights are presented in Table A-xi below.

The capital estimates for the mining industries are obviously subject to a considerable margin of error, and are probably the least reliable of the industry series. For this reason, we show the index numbers for capital and the output-capital ratios only for key years, while using the annual series in deriving annual estimates for total input and total factor productivity.

Manufacturing. The estimates of real capital stock in manufacturing industries are taken from Daniel Creamer of the Conference Board. The key-year estimates of net capital for this class and its two-digit industries presented in *Productivity Trends* were also taken from Creamer.[31] The net capital input estimates for the group as a whole, shown for the period since 1929 in this study, are bench-marked prior to 1948 by the estimates for key years given in the earlier volume, interpolated annually by the OBE real net capital stock estimates for manufacturing, described in Part I, and presented in Table A-15. Gross capital inputs for the key years 1929-48 are obtained by applying ratios of real gross to net capital inputs based on OBE estimates, with annual interpolations made by use of the OBE real gross capital stock estimates (Table A-16).

Creamer's method consists essentially in assembling asset data from the IRS *Statistics of Income* balance-sheet aggregates for manufacturing industries, making a number of adjustments, and then converting the various major categories of assets from book values to constant dollars. Although Creamer treats all types of assets, including the financial items, we use only the real asset categories—equipment, structures, land, and inventories. Creamer's estimates were available only through 1963, so we extended his series through 1966, using similar sources and methods.

[31] See *Productivity Trends*, Appendix D, and *Capital in Manufacturing and Mining*, NBER, 1960.

For the period since 1953-63, Creamer has used more elaborate and somewhat revised procedures compared with those described in his earlier published works.[32] In particular, he used balance sheet data for three-digit industries, and summed to two-digit industry and manufacturing group totals. Creamer's three-digit estimates of fixed capital (structures and equipment) start with the balance sheet data for fixed capital from the IRS Source Book. Industry classifications were rearranged to provide a reasonably comparable set of industry classification. Fixed capital in each three-digit industry was partitioned into separate estimates of the stock of structures and the stock of equipment on the basis of Patrick Huntley's separate estimates of the stock of structures and stock of equipment by three-digit industries.[33] Adjusting the book-value data and deflating by three-digit detail presumably increases the accuracy of the two-digit industry and group estimates. The chief adjustments are for inclusion of government-owned but privately-operated manufacturing facilities, and to normalize the accelerated depreciation allowed on emergency facilities acquired during World War II and the Korean conflict. The estimates do not include an upward adjustment for manufacturing plants rented from nonmanufacturing firms, which amounted to about 3.5 per cent of the book value of structures in 1957.

Asset totals for corporations submitting balance sheets were raised to the total corporate level, by industry, by the ratio of gross sales of the former to the total group given in *Statistics of Income.* To achieve coverage for unincorporated manufacturing enterprises, the relationship of value of product for all establishments, as given in the *Census of Manufactures*, to the value of product of corporate establishments was applied to the corporate totals, with straight-line interpolation of the ratios between census years.

With respect to deflation of book values to constant prices, Creamer was able to treat structures and equipment separately. The underlying price indexes were those developed by OBE for manufacturing structures (constant cost 2) and equipment, described in Part I. By reference to the average lengths of life and annual plant and equipment expenditures (from Huntley), Creamer estimated the proportions of the depreciated book values of struc-

32 See D. Creamer, *Capital Expansion and Capacity in Postwar Manufacturing*, Studies in Business Economics No. 72, National Industrial Conference Board, 1961, Appendixes; and *Recent Changes in Manufacturing Capacity*, Studies in Business Economics No. 79, NICB, 1962.

33 See the unpublished manuscript by Patrick Huntley "Capital Assets: The Wellspring for Economic Growth—A Study in Estimation of Manufacturers' Depreciable Capital Assets. . . ," University of Arkansas.

tures and equipment in each year acquired in previous years. These proportions were used to weight the price index values for the current and prior years, and the weighted index for each year was applied to book values in order to convert from original costs to constant prices.[34] For structures, an average life of forty-five years was used throughout. Average equipment lives were based on the IRS's (1962) *Depreciation Guidelines and Rules*. The weights for the price indexes differed by industry depending on the annual expenditure services, which were based on the *Census of Manufactures* and the *Annual Survey of Manufactures* for intercensal years after 1948.

For inventories, a different index was compiled for each industry, composed of a weighted average of the appropriate BLS wholesale price indexes.

The 1958 ratio of the value of land to the value of structures, by industry, was applied to the estimated values of structures in constant prices for the entire period. The value of land is reported by IRS. For all manufacturing, land values represented about 4 per cent of the value of structures in 1958.

As compared with the OBE perpetual inventory method of estimating the fixed depreciable capital stock, Creamer sees some advantages in using the method of adjusting balance sheet data. In particular, the balance sheets reflect actual company practice, and changes in practices, with respect to retirements and discards.[35] Despite the differences in methods, however, the real net stock estimates of Creamer and OBE show much the same movements over the period, particularly after 1953. (Table A-x, columns 1, 2, and 4.) The levels of the estimates differ significantly, however. Creamer suggests that the higher level of his estimates is due in part to a faster rate of retirement used by OBE in the perpetual inventory method than that implicit in the balance sheet approach. Upward revaluations and inclusion of some nonmanufacturing facilities would also have affected the balance sheet data to some extent, but part of the differences in level remains unexplained.

In order to obtain our estimates of capital input for all manufacturing, and the durables and nondurables subsegments, we weighted the real stock estimates for the twenty-one two-digit industries by the unit compensation in 1958 for 1953-66, and by average unit compensation in 1948 and 1953 for

[34] For a more detailed description, see Creamer, *Capital Expansion and Capacity*, NICB, 1961, Appendix A.

[35] For a detailed discussion of the alternative sources and methods, see Creamer, "Some Notes for Users of Capital Stock Estimates in Manufacturing," *Proceedings of the Business and Economic Statistics Section of the American Statistical Association*, 1968.

TABLE A-x

Alternative Capital Stock Estimates,
Total Manufacturing, 1929-66
(index numbers, 1958=100)

Year	Real Net Stock		Weighted Net Stock (Based on Creamer)	Ratios of Indexes	
	OBE (1)	Creamer (2)	(3)	Real Net Stock (Col. 2÷ Col. 1) (4)	Weighted Vs. Unweighted (Col. 3÷Col. 2) (5)
1929	55.3	62.2	59.1	1.125	0.950
1930	57.6	63.1	61.2	1.095	0.970
1931	57.1	62.3	60.3	1.091	0.968
1932	53.6	59.6	56.3	1.112	0.945
1933	50.0	56.3	52.2	1.126	0.927
1934	48.0	53.9	49.8	1.123	0.924
1935	47.2	52.4	48.7	1.110	0.929
1936	47.6	51.7	48.8	1.086	0.944
1937	49.6	52.0	50.5	1.048	0.971
1938	49.9	52.7	50.9	1.056	0.966
1939	48.9	52.2	50.1	1.067	0.960
1940	50.1	53.4	51.4	1.066	0.963
1941	54.0	56.7	55.6	1.050	0.981
1942	57.7	59.3	59.6	1.028	1.005
1943	58.5	59.3	60.6	1.014	1.022
1944	57.4	58.2	59.6	1.014	1.024
1945	55.8	57.2	58.1	1.025	1.016
1946	59.2	60.1	61.8	1.015	1.028
1947	64.5	66.6	67.5	1.033	1.014
1948	68.0	73.2	71.4	1.076	0.975
1949	70.5	75.2	73.3	1.067	0.975
1950	72.2	75.5	73.8	1.046	0.977
1951	77.5	79.4	78.3	1.025	0.986
1952	83.3	86.2	85.5	1.035	0.992
1953	87.0	89.1	88.8	1.024	0.997
1954	88.9	89.6	89.2	1.008	0.996
1955	90.5	90.1	89.9	0.996	0.998
1956	90.8	95.4	95.1	1.051	0.997
1957	99.0	99.0	98.7	1.000	0.997
1958	100.0	100.0	100.0	1.000	1.000
1959	100.9	101.2	101.6	1.003	1.004
1960	103.0	102.8	103.7	0.998	1.009
1961	104.4	103.5	104.9	0.991	1.014
1962	106.3	104.9	106.6	0.987	1.016
1963	108.6	109.1	111.1	1.005	1.018
1964	111.6				
1965	116.7				
1966	125.3				

this period. The relative weights are shown in Table A-xi. The weighted index for all manufacturing rises a bit faster than the unweighted total real capital stock, as shown in Table A-x, columns 2, 3, and 5.

Transportation. The real capital stock estimates for total transportation are the sum of estimates for the railroads and the aggregate nonrail components.

TABLE A-xi

Manufacturing and Mining Industries,
Relative Weights for Gross and Net Real Capital,
1948-53 and 1958
(per cent)

	Gross Capital		Net Capital	
	1948-53	1958	1948-53	1958
Total Manufacturing	100.0	100.0	100.0	100.0
Nondurables	48.7	50.1	50.2	52.5
Foods	6.0	8.3	5.4	8.4
Beverages	2.9	2.8	2.6	2.8
Tobacco	1.1	1.9	1.3	2.5
Textiles	3.7	2.9	4.1	2.7
Apparel	1.8	1.7	1.7	2.1
Paper	5.1	5.2	4.9	4.9
Printing, publishing	2.0	2.7	1.7	2.5
Chemicals	11.9	12.9	11.2	13.1
Petroleum refining	11.5	8.9	14.9	10.7
Rubber products	2.0	2.3	1.7	2.2
Leather products	0.7	0.5	0.7	0.6
Durables	51.3	49.9	49.8	47.5
Lumber products	2.0	2.0	1.5	1.3
Furniture	0.6	0.7	0.5	0.6
Stone, clay, glass products	4.0	5.0	3.9	5.0
Primary metals	11.1	11.3	10.4	10.0
Fabricated metals	4.9	4.8	4.8	4.8
Machinery except electric	7.4	7.4	6.7	6.9
Electric machinery	5.1	6.1	5.6	6.8
Transportation equipment and ordnance	12.3	8.9	12.6	8.2
Instruments	1.9	2.2	2.0	2.4
Miscellaneous	2.0	1.5	1.8	1.5
Total Mining	100.0	100.0	100.0	100.0
Metal	11.0	7.7	22.1	12.3
Coal	10.7	8.2	13.8	10.3
Oil and gas	66.4	75.6	47.5	65.3
Nonmetal	11.9	8.5	16.6	12.1

Railroads. The 1948 current dollar net stock of road and equipment was taken from Ulmer's *Capital in Transportation, Communications, and Public Utilities*, Table C-1, page 256. This base stock was converted to 1958 constant dollars by the *Railroad Construction Price Index* published by the Bureau of Accounts of the ICC. The 1948 stock estimate was then extended by cumulation of real net investment data.

The series on gross outlays for new plant and equipment by railroads is from the investment surveys conducted by the OBE and SEC (see, for example, Genevieve B. Wimsatt, "Business Expects Plant and Equipment Expansion and Larger Sales in 1964," *Survey of Current Business*, March 1964, Table 7, p. 13), and was converted to 1958 constant dollars by the above deflator. The average ratio of depreciation to the preceding end-of-year stock for 1945-58 was applied to the yearly stocks to get yearly depreciation. The 1949 net stock was accumulated by adding gross expenditures in 1949 to Ulmer's 1948 stock less depreciation in 1949, all in constant 1958 dollars. This process was continued to build up the net stock through 1966. Gross stock was obtained by applying the ratios of real gross to net stock, as estimated by M. Gort. (Gort's sources and methods are described below in the section covering capital in "other industries.")

Nonrail Transportation. For the nonrailway transportation component, the base stock for 1948 was also taken from Ulmer's *Capital in Transportation* (Table B-7, p. 244). It is the sum of the following industries: local transit, trucking, other motor vehicles, pipelines, water transportation, air transportation, transportation services, and miscellaneous transportation. The expenditure series on plant and equipment for transportation other than railway is from the OBE-SEC survey mentioned above for railroads. The price deflator used was a simple average of the implicit price deflators for ships and boats, aircraft, and trucks and buses. The estimation process was the same as that explained for railroads: applying the depreciation ratio to the preceding year-end stock to get the yearly depreciation, then adding the yearly capital expenditure to the preceding year-end stock and subtracting the depreciation, all in constant 1958 dollars. The process was continued to cumulate the stock from 1948 to 1966.

The real gross stock was obtained by applying the ratios of real gross to net stock for the sum of water and air transportation, as estimated by Gort (see below).

As just implied, we have separate and independent estimates of real capital stocks for two of the nonrail industries. The capital estimates for the water

transportation industry were based entirely on Gort's estimates, extended to 1966 by his sources and methods as described below.

The real net capital stock estimates for airlines were also based on Gort for the period 1948-57. In 1957 they were linked to the estimates of Joseph E. Dragonette, described in his master's thesis (1966) on file at The George Washington University. Briefly, he used book-value data from the FAA, converted to current replacement costs by appropriately weighted price indexes for aircraft, other equipment, and buildings and then deflated to constant (1958) prices. Gort's real gross-to-net ratios were applied to the net stock estimates for the entire period in order to obtain the gross series.

Other Industries. The real gross and net capital stock estimates for the remaining industries—contract construction, wholesale and retail trade, communication and public utilities—are based on the estimates prepared by Gort for the period 1948-63.[36] They were extended to 1966 by the author, using methods and sources similar to those employed by Gort where possible.

Gort's basic methodology was to derive real gross and net stock estimates from deflated gross investment estimates by means of the perpetual inventory approach. He derived several variants of the net stock series, of which we chose the variant based on straight-line depreciation for consistency with our private economy aggregates.

The gross investment estimates for all of his industries (including mining and manufacturing, which we did not use), except the regulated areas, were obtained from the successive balance sheets and income accounts for corporations compiled by the Internal Revenue Service (IRS).[37]

He calculated the annual changes in net fixed assets from year-end balance sheet totals, and added depreciation, depletion, and amortization from the income statement compilations. He also made a number of adjustments to the published data: For years in which it was apparent that significant revaluations had been made, particularly in the 1930s, he interpolated the published data. He extrapolated the series prior to 1927 or 1931, when the IRS compilations began. He adjusted for occasional changes in accounting methods, particularly with regard to consolidation of returns, as well as for occasional changes in industry classifications (by means of transition tables in 1948 and 1958), and switched from a company to an establishment basis where indicated. Finally, he adjusted the industry estimates to cover unincor-

[36] See R. Boddy and M. Gort, "The Derivation of Investment Expenditures," and "The Derivation of Capital Stocks," mimeograph.

[37] IRS, *Statistics of Income* and *Source Book of the Statistics of Income.*

porated as well as corporate enterprises, except for contract construction and wholesale and retail trade. In these three industries we made the required coverage adjustment to the stock estimates by dividing by the ratio of corporate to total national income originating, based on OBE estimates.

For purposes of price deflation and cumulation over estimated average lives, Gort broke down the gross investment estimates into structures and eleven types of equipment. Structures were deflated by the OBE implicit deflator for new private nonresidential construction, and the equipment categories were deflated by various OBE equipment price indexes, published and unpublished.

Average lives for the structures and various types of equipment were based on the Treasury Department study *Life of Depreciable Assets Survey*. Published in 1962, the IRS survey reflects actual tax lives in use during the period 1954-59. The lives are somewhat shorter than those contained in Bulletin "F," but somewhat longer than those permitted by the more recent IRS *Depreciation Guidelines and Rules*.

Retirements for each type of investment were made at the end of the average life of each, rather than being spread over a mortality curve. But since the investment estimates were prepared by a dozen types, there is a considerable spread of retirements resulting from each year's investment. The same is true of depreciation, which was also calculated separately for structure and equipment by type.

Gort's estimates cover fixed capital. For wholesale and retail trade we added constant dollar estimates of inventories, based on the OBE series used for private economy aggregates. In the other nonfarm nonmanufacturing industries we did not include inventories since they are small relative to fixed capital and data are not readily available.

Year-end stock estimates were averaged to approximate annual averages. All series were shifted to a 1958 base.

Industry and Sector Aggregates

In table A-xii we summarize the real net stock estimates for all industry groups within the private business economy, excluding farming, manufacturing and residential real estate, for which we have estimates. These estimates are deducted from the independent estimates for the sector as a whole (see Table A-15), and the residual is shown in the last line.

The residual comprises primarily finance, insurance, and real estate (other than residential); service, including government enterprises but excluding households and nonprofit institutions; and the small group of agricultural services, forestry, and fisheries.

TABLE A-xii

Private Domestic Nonfarm Business Economy, Excluding Manufacturing and Residential, Real Net Stocks of Capital, by Industry, Including Residual Sector: Selected Years, 1948-66 (billions of 1958 dollars)

	1948	1953	1958	1963	1966
Total private nonfarm, nonresidential, nonmanufacturing business	203.4	249.5	305.8	360.2	416.4
Mining	18.6	18.2	18.8	19.3	18.0
Contract construction	2.1	3.7	5.5	7.7	9.1
Transportation	62.3	70.8	75.8	78.6	83.7
Communication	11.3	15.0	20.9	27.5	33.6
Electric and gas utilities	28.8	43.4	53.6	68.6	76.2
Trade	49.7	64.4	75.1	87.9	103.3
Residual[a]	30.6	34.0	56.1	70.6	92.5

[a] Residual relates chiefly to finance and services, obtained by subtracting covered industry totals from sector totals

Over the period 1948-66, the real net capital stock in the residual sector approximately tripled, while only doubling in the sector as a whole. This 10.8 per cent faster growth resulted in an increase in the residual sector's share of capital in the sector as a whole from 15 per cent in 1948 to about 22 per cent in 1966. This may be compared with a relative growth of real product in the residual industries from 26.7 per cent of real product in the sector in 1948 to 27.4 per cent in 1966. These figures imply that the capital coefficient in the residual sector is lower than in the sector as a whole, but that it has increased relatively.

On its face, the behavior of the real capital stock in the residual industries is not unreasonable. We may conclude, therefore, that the capital estimates for the various covered industries are broadly consistent with the estimates for the private domestic business economy as a whole. We have not made use of the residual capital estimates other than for this rough check on the consistency of the estimates for the covered industries with those for the entire business sector.

Total Inputs

For the various industry segments and groups, the index numbers of real capital and labor inputs were combined according to relative unit compensation in the base periods. Table A-xiii gives the percentage weights in 1958, and during 1948-53, for both the net and gross capital variants. Since the

TABLE A-xiii

Private Domestic Business Economy, by Industry Segment and Group: Gross and Net Capital Weights, 1948-53 and 1958, Based on Capital Shares of Unit Factor Income
(per cent)

	Gross Capital Input		Net Capital Input	
Industry Segments and Groups	1948-53	1958	1948-53	1958
Farming	54.2	52.6	46.0	42.9
Mining	47.6	46.1	30.9	20.9
Metal	45.9	34.4	46.5	20.4
Coal	25.9	19.9	18.5	8.8
Oil and gas	56.3	59.1	31.9	27.9
Nonmetal	44.4	33.5	36.0	18.2
Contract construction	21.2	13.2	15.4	7.7
Manufacturing	33.9	24.5	29.6	18.2
Nondurables	37.4	28.8	33.8	22.5
Foods	26.7	23.7	21.3	17.6
Beverages	48.8	39.7	41.1	31.4
Tobacco	58.3	57.6	57.0	56.2
Textiles	29.6	19.9	28.0	13.9
Apparel	14.4	11.0	11.9	9.0
Paper	42.4	32.5	37.0	23.7
Printing, publishing	14.7	13.0	10.6	8.5
Chemicals	51.8	41.3	45.6	32.8
Petroleum refining	73.4	56.5	74.6	51.7
Rubber products	30.5	24.9	24.5	18.1
Leather products	17.2	10.0	15.2	7.7
Durables	31.1	21.4	26.5	15.0
Lumber products	24.1	17.4	17.1	9.0
Furniture	12.5	9.9	9.2	6.0
Stone, clay, glass products	37.2	31.9	32.2	23.9
Primary metals	42.1	30.1	35.9	20.6
Fabricated metals	26.1	18.1	22.0	13.1
Machinery except electric	28.5	20.0	22.9	13.6
Electric machinery	24.8	20.0	22.8	15.9
Transportation equipment and ordnance	33.0	17.6	29.4	11.8
Instruments	31.0	23.3	28.4	19.1
Miscellaneous	32.2	18.6	26.6	13.5
Transportation	26.5	18.0	15.5	4.7
Railroads	34.9	21.2	25.4	9.5
Nonrail	26.2	16.9	10.3	2.5
Water transportation	25.2	10.5	12.2	5.7
Air transportation	42.6	9.4	10.3	2.5
Communication and public utilities	50.6	52.1	44.5	42.5
Communication	38.4	42.7	31.2	36.1
Telephone and telegraph	40.5	44.2	32.6	38.0
Electric, gas and sanitary services	60.3	59.8	55.2	48.5
Electric and gas utilities	61.0	59.7	56.2	48.7
Trade	25.9	15.6	20.3	9.3
Wholesale	30.8	20.7	24.4	15.3
Retail	24.0	12.5	18.4	6.0

quantity units are index numbers, the relative weights for 1958 are the factor proportions of net and gross national income originating; for 1948-53, however, the average factor compensations are divided by the average factor input indexes for the two years, and weights are based on the proportions of total unit factor compensation (net and gross) so derived. The indexes of real total inputs are presented in the summary tables referred to below.

Industry Summary Tables

Summary data on output, input, and productivity for the various industry segments, subsegments, and two-digit groups are presented in Tables A-22 through A-80. For several of the groups and industries, capital series are not available as noted above, and only output, labor input, and labor productivity index numbers are shown for these. For all the groups and industries where capital estimates are available, the gross capital and associated gross factor input and productivity series are shown in the "a" supplements to the basic tables which contain the net capital series. For the segments and groups with both gross output and real product estimates, both variants of the productivity ratios are presented. For the two-digit industries, it will be recalled, only the gross output and associated productivity measures are available. Similarly, for some of the industry groups only the real product and associated productivity measures are presented.