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APPENDIX D

Manufacturing

THE indexes of output and employment in the manufacturing segment, groups, and industries are built primarily upon those constructed by Solomon Fabricant[1] and extended by the Census Bureau.[2] The indexes of real net capital assets for manufacturing groups and selected subgroups of industries are based on those prepared by Daniel Creamer,[3] adjusted for consistency of coverage with the Fabricant indexes.

We went somewhat further afield than previous National Bureau investigators in exploiting average hours data from the Census and other sources to combine with the employment series. This was necessary to achieve the goal of using weighted manhours throughout as a measure of real labor input for combination with capital input in constant dollars. We have also occasionally supplemented the Fabricant output indexes, which are based exclusively on physical quantity data, by deflated value estimates in those cases in which price information was available. For manufactured foods, we supplemented estimates of gross output in constant dollars by estimates of the deflated value of intermediate products consumed in order to arrive at estimates of real net output.

Since earlier National Bureau volumes contain full descriptions of the sources and methods underlying the basic estimates, these will be summarized only briefly here. In these notes, we will be more concerned with areas in which we have extended, supplemented, or adjusted the original indexes. Similarly, the major appendix tables are largely confined to indexes, since most of the basic data are readily accessible in the previous Bureau volumes, and the data underlying the estimates used for extension and supplementation may be found in the sources cited. Total and partial productivity ratios are presented for all the manufacturing groups and selected subgroups, and output per manhour estimates are presented for a wide range of SIC 4-digit industries or combinations thereof.

[1] *The Output of Manufacturing Industries in the United States, 1899–1937*, New York (NBER), 1940; and *Employment in Manufacturing, 1899–1939: An Analysis of Its Relation to the Volume of Production*, New York (NBER), 1942.

[2] *Census of Manufactures, 1947, Indexes of Production*; and *Census of Manufactures, 1954*, Vol. IV, *Indexes of Production*.

[3] Daniel Creamer, Sergei Dobrovolsky, and Israel Borenstein, *Capital in Manufacturing and Mining: Its Formation and Financing*, Princeton University Press (for NBER), 1960.

APPENDIX D

Classification

MANUFACTURING SEGMENT

The basic source of data relating to manufacturing activities is the *Census of Manufactures*. The classification and definition of industries and industry groupings used in the 1947 and 1954 Censuses is almost identical with that outlined in the Budget Bureau's *Standard Industrial Classification Manual*, Volume I, of November 1945. The Census quotes the *Manual* definition of manufacturing as follows: "the mechanical or chemical transformation of inorganic or organic substances into new products. These activities are usually carried on in plants, factories, or mills, which characteristically use power-driven machines and materials-handling equipment. Manufacturing production is usually carried on for the wholesale market, for interplant transfer, or to order of industrial users rather than for direct sale to the household consumer."[4]

Over the years the scope of the activities classed as manufacturing by the Census has changed somewhat. The tendency has been to drop industries whose inclusion in manufacturing seemed doubtful. A major change occurred in 1904, when neighborhood industries and hand trades were excluded, and figures for 1899 were reclassified accordingly. Some other important industries subsequently dropped are motion picture production, manufactured gas, automobile repairing, and railroad repair shop products. Fabricant adjusted the Census data for earlier years to conform to the 1937 definition of manufacturing.[5] Since the differences in scope of the 1947 and 1954 Censuses compared with the 1937 Census were quite minor,[6] the Fabricant segmental output and employment indexes for 1939 were extrapolated forward by the Census indexes for 1939, 1947, and 1954 without further adjustment.

[4] *Census of Manufactures, 1947*, Bureau of the Census, Vol. I, p. 3. The further discussion clarifies the definition as it relates to borderline areas, departures from common usage, and the several instances in which the Census departs from the SIC (see also *ibid.*, Appendixes C and E). The SIC was amended to some extent prior to the 1954 Census, but the changes were not basic.

[5] See Fabricant, *The Output of Manufacturing Industries* Appendix C, pp. 637–639. A very informative general discussion of the *Census of Manufactures* is contained in a book that appeared as the present study was being prepared for press: Frank A. Hanna, *The Compilation of Manufacturing Statistics*, Bureau of the Census, 1959.

[6] In 1947, two activities—coffee and spice roasting and grinding and tobacco stemming and redrying—accounting for $147 million of value added, were newly included; eight activities were dropped, of which bakery products produced in retail bakeries, logging camps and contractors, and certain repair activities were the most important, accounting for $96 million of value added (*Census of Manufactures, 1947*, Vol. I, pp. 6–7). In 1954, establishments engaged primarily in processing milk and in packaging seafood were added. The 1947–54 comparisons were adjusted accordingly (see *Census of Manufactures, 1954*, Vol. I, Appendix A; see also *Historical Comparability of Census of Manufactures Industries, 1929–1958*, Bureau of the Census Working Paper No. 9, 1959).

Within the manufacturing segment as defined, the Census Bureau has collected data from virtually the entire universe of establishments, with the exception of the very small. The degree of coverage probably did not vary significantly over the years until 1954. In the 1939 and earlier biennial censuses, the cutoff point for establishments to be included was at a value of product of $5,000. In 1947, the criterion was changed to exclude establishments with no employees—a procedure which made possible use of the Social Security Administration files. "This change in procedure has not, however, appreciably affected the comparability of the figures for 1947 with those for earlier years except for the figures on number of establishments."[7] The Census officials, on the basis of a carefully conducted sample survey, estimated that in 1947 the Census tables included 98.2 per cent of all manufacturing employment and 98.7 per cent of total wages and salaries. In addition to omission of the small establishments, there was some undercoverage of establishments whose classification in manufacturing was questionable and of establishments that operated during only part of the census year. Coverage in 1954 was believed to be complete, however. Consequently, for purposes of comparison, the Census Bureau adjusted upwards its estimates of output in all manufacturing and the major groups for 1947 by the estimated percentages of undercoverage.

MANUFACTURING INDUSTRIES

The basic grouping of establishments for which we compute productivity ratios is the "industry," identified by SIC 4-digit code numbers. In order to interpret productivity measures in terms of the real activities they describe, it is necessary to understand the Census definition of an industry and the principles by which the definition is implemented statistically. The classification is designed to "conform to the existing structure of American industry."[8] The industry is defined as an economically significant group of establishments engaged primarily in the same or similar lines of productive activity generally characterized by the products made or manufacturing processes employed. The establishment is generally identified in terms of a single physical location where a distinctive and reportable activity takes place.

It would be convenient if industries and products were coterminous—performance measures would be simpler to understand and less complicated to construct. But most establishments produce a number of products, and whereas output data can be collected on a product basis, cost data can not be so allocated except on a grossly arbitrary basis. Consequently, an industry is usually defined in terms of a group of products which are

[7] *Census of Manufactures, 1947*, Vol. I, p. 6.
[8] *Ibid.*, p. 7.

"primary" to it. Descriptions of the various industries and groups by principal primary products, together with code numbers and titles, are given in the censuses.[9]

The Census classification scheme places primary emphasis on aspects of supply—homogeneity of production or of technology—rather than on economic demand characteristics, such as close substitutability and high "cross-elasticity." The two criteria may frequently coincide. On the other hand, similar types of products may not be substitutable, or substitute commodities may be placed in different industries (e.g., tin cans and glass containers).

The Census Bureau attempts to apply the classification principles so as to maximize the homogeneity or similarity of activity of the establishments in an industry. That is, the industry is defined in terms of a range of products typically produced in large proportion by a number of establishments; and an establishment is assigned to a given industry if the plurality of its products (processes or operations)—usually as measured by value of products shipped—comes within the industry definition. The classification scheme is affected by the extent to which most of the establishments within an industry tend to produce the full range of primary products. If a significant number of the establishments concentrated on but a portion of the activities defining the industry, this would constitute a basis for further subdivision.

Homogeneity and overlapping. The average "industry homogeneity" for all manufacturing establishments in 1947 was 90 per cent (the proportion of value of output comprising primary products). Only twenty-five industries, accounting for less than 6 per cent of total value added in manufacturing, were completely homogeneous in the sense that their shipments comprised primary products exclusively. It should be kept in mind, however, that homogeneity is relative to the definition of the industry, and the products which are primary to an industry may exhibit considerable variety.

Table D-1 shows the distribution of industries in the 1947 Census according to degree of homogeneity. Since our classifications involve quite a few combinations of the 1947 industries, the homogeneity of the combined industries is even higher. That is, the more broadly an industry is defined, the greater the homogeneity of a given group of establishments. This partially explains why the data given by Fabricant for 1929 on the basis of 285 industries show greater homogeneity, or "degree of specialization" as it is called there, than the data for the 453 industries distinguished in 1947.[10] If the industries that appear to be defined identically in 1929

[9] See *Census of Manufactures, 1947*, Vol. I, Appendix C; and *Census of Manufactures 1954*, Vol. I, Appendix A.

[10] Fabricant, *The Output of Manufacturing Industries*, Table A–2, p. 336.

and 1947 were analyzed, the average homogeneity measure would provide some indication of the changing degree of diversification of establishment output.

TABLE D-1

Frequency Distribution of Manufacturing Industries, by Degree of Homogeneity and Extent of Overlapping of Products, 1947

Percentage Class	*Degree of Homogeneity*[a] Number of Industries	Value Added (millions)	*Extent of Overlapping*[b] Number of Industries	Value Added (millions)
Less than 50	...	$ ...	19	$ 1,737
50–59	1	18	9	479
60–69	6	439	19	1,231
70–79	37	2,772	50	4,226
80–89	129	19,238	110	16,458
90–99	255	47,820	207	38,212
100	25	4,139	35	11,909
No data	...	...	4	174
Total	453	74,426	453	74,426

SOURCE: *Census of Manufactures, 1947*, Vol. II, Table 5, for each industry. Summary adapted from Maxwell R. Conklin and Howe T. Goldstein, "Census Principles of Industry and Product Classification, Manufacturing Industries," *Business Concentration and Price Policy*, Special Conference Series, Vol. 5, Princeton Unversity Press (for NBER), 1955, Tables A-4 and A-5, pp. 33–34.

For a similar tabulation for 1954, see *Census of Manufactures, 1954*, Vol. I, Appendix A, Table 1, p. A-1; a comparison of substantially identical industries for 1947 and 1954 is shown in Table 2, p. A-2.

[a] Value of primary products as percentage of total value of industry output.

[b] Value of primary products as percentage of value of total output of these products.

The corollary of the fact that establishments in most industries produce secondary products is that the establishments of many industries do not account for all of the output of the primary products which define those industries. The second part of Table D-1 shows the distribution of establishments according to the "extent of overlapping" (percentage coverage of primary activity). The average amount of overlapping in 1947 was also about 10 per cent. Changes in both ratios were relatively minor between 1947 and 1954. Whereas more industries accounted for all of their primary activity than the number that produced only primary products, there were more industries with 30 per cent or more overlapping than was the case with the homogeneity measure. It is the degree of homogeneity, however, that is significant as regards the validity of "coverage adjustments" discussed in connection with output measures.

Industry detail. In general, the industry classifications shown by Fabricant are employed in this study. Fabricant used the 1929 Census classification involving 326 separate industries because this represented the smallest number of industries covered by the censuses since 1899. Thus, continuous estimates could be presented by combining "subindustries" presented in earlier and later censuses. Since the 1947 Census used a 453-industry classification and the 1954 Census, a 447-industry classification, considerable combination was involved in extending the Fabricant estimates. In a few cases, some of the Fabricant industries had to be combined in order to establish continuity with the 1947 industry definitions.

From time to time, in addition to combining or splitting industries, the Census Bureau has changed the definitions of certain industries. Usually overlaps have been provided, making possible the linking of input and output estimates, which then should be interpreted in conjunction with the changed industry definitions. Tables D-V and D-VI indicate the content of the industries in terms of the 1947 Census code numbers, although the Fabricant titles are sometimes retained when the grouping is broader than in 1947. Due to the many changes in definitions in 1947 as compared with earlier censuses, the Fabricant study and the 1947 and 1939 Census volumes should be consulted to determine the precise content of each industry prior to the 1939 overlap with data for that industry as defined in the 1947 Census.[11] In a few cases in the historical series, industry definitions changed without overlaps being given. Although a change would affect both the output and the employment estimates, it could disturb the continuity of the productivity estimates if it were large. Such changes are indicated in footnotes to the Fabricant tables in his Appendix C.

GROUPS OF INDUSTRIES

For purposes of description and analysis, it is helpful to combine the industries of a large segment like manufacturing into groups characterized by at least a broad similarity of primary product. The 1947 Census, following the SIC, combined the various industries into twenty major industry groups. Fabricant employed the fifteen groups distinguished in the 1937 Census plus beverages and tobacco products, which were split off from the food group. In a few cases, he transferred industries from one group to another for the sake of consistency. We used the 1947 Census

[11] Appendix D of *Census of Manufactures, 1947*, Vol. I, tabulates the 1939 Census industries equivalent to each of the 453 industry classifications used in the 1947 Census. A similar table is given in Appendix E, Vol. I, of the 1939 *Census of Manufactures* comparing 1939 and 1937 classifications. For the several rearrangements in 1954 of the 1947 industries, see *Census of Manufactures, 1954*, Vol. I, Appendix B.

groups (also used in 1954) plus beverages, a practice that involved the following further breakdown or rearrangement of the 1937 groupings used by Fabricant:

1937 Group	*1947 Group*
Textile products	Textile mill products Apparel and related products
Forest products	Lumber and products except furniture Furniture and fixtures
Machinery	Machinery except electrical Electrical machinery
Iron and steel Nonferrous metals	Primary metal industries Fabricated metal products
Miscellaneous	Instruments and related products Miscellaneous manufactures

The 1939 and 1947 Censuses shifted industries among some of the groups as defined by Fabricant after the regrouping described above. The net result of these shifts on the groups relative to the Fabricant (1937) definitions are summarized in Table D-2. The miscellaneous group is not shown as such because all single entries in the table represent transfers to or from the miscellaneous group. Industries are listed here only if they were shifted in their entirety or in major part. In a few instances, minor portions of industries were transferred, as indicated in the 1947 Census, Vol. I, Appendix D.

Since only half the groups were affected by these transfers, and since the transfers were not important in terms of value added except in the miscellaneous group, measures for 1939 and later years in terms of the 1947 classifications were linked to those of Fabricant as expanded. This made it unnecessary to adjust the earlier indexes (1899–1939), but the slight break in continuity in terms of contents of the several industry groups should be kept in mind. Although the expansion of the miscellaneous group has been substantial, measures for this group have an ambiguous meaning in any case because of the product heterogeneity. There were no shifts of industries across group lines between the 1947 and the 1954 censuses. We have combined Major Group 19, Ordnance, with Fabricated metal products for consistency with our employment estimates.

The 1947 Census further divided the major groups into 141 subgroups comprising one or several closely related individual industries. This classification has generally not been used here since it was not necessary for the analysis and output indexes were lacking for many of the component industries. We did, however, use certain subgroupings in order to employ capital estimates that were available for combinations of industries.

TABLE D-2

Industry Shifts among Manufacturing Groups, 1937–1947

Group (1947 classification)	Industries Shifted
Textile products	*Out* Furs, dressed and dyed
Forest products	*Out* Cork products Matches Morticians' goods Billiard tables Fabricated plastics products, n.e.c. Turpentine and rosin (gum naval stores)
Furniture	*In* Mattresses and bedsprings Window shades
Paper products	*In* Wallboard and wall plaster
Chemical products	*Out* Small arms ammunition Fireworks Candles *In* Turpentine and rosin (gum naval stores)
Petroleum and coal products	*In* Paving and roofing materials
Stone, clay, and glass products	*Out* Wallboard and wall plaster Paving and roofing materials *In* Steam and other packing; pipe and boiler covering (gaskets and asbestos insulations)
Fabricated metal products	*Out* Small arms Silverware and plated ware Jewelry Watches and clocks Watch cases Fire extinguishers Needles, pins, and fasteners

(continued)

n.e.c. = not elswhere classified.

TABLE D-2 (concluded)

Industry Shifts among Manufacturing Groups, 1937–1947

Group (1947 classification)	Industries Shifted
Machinery (nonelectric)	*Out* Mechanical measuring instruments
	In Models and patterns
Transportation equipment	*Out* Children's vehicles (carriages and sleds)
Instruments	*In* Watches and clocks Watch cases Mechanical measuring instruments

These subgroups do not necessarily correspond to 1947 Census classifications, but their precise industry content is indicated on Tables D-V and D-VI by Census code numbers.

Current Value Estimates

While our ultimate interest is in physical-volume estimates, it is necessary to examine the nature of the Census current value data. The value estimates are used to adjust partial physical-volume data to full coverage, or they are directly adjusted for price change as an alternative method of estimating real output, as explained in a later section.

VALUE OF PRODUCT

The product value data collected in most census years relate to the value of the quantities of finished commodities produced in factories and to the value of certain services rendered. The values are received or receivable net selling values, f.o.b. plant, after discounts and allowances. The value assigned to products transferred from one establishment to another of a multi-unit enterprise is generally the approximate commercial value.

Reports are obtained on a calendar-year basis from the great majority of firms, regardless of the basis of their own records. In a few industries, such as agricultural machinery and fertilizer, a fiscal year ending prior to December 31 is the reporting basis for value data (but not employment and payrolls). In these cases, the value figures may be somewhat understated during periods of expansion, and overstated during contractions, in comparison with "true" calendar-year totals.

In 1929, in lieu of production data, the value of products shipped was collected for the majority of industries; in 1947 and 1954, the shipments basis was general, although data on production were requested whenever it seemed likely that shipments would differ significantly from production. Figures relating to production were used in this study where available. The Census Bureau has stated, however, that shipment values are generally comparable with production values as reported in most of the censuses.

> In the first place, it is likely that in previous censuses many manufacturers valued their output in terms of shipments even though value of production was requested. Secondly, the changes in the quantity of finished goods inventories for most industries were of minor importance and there was, therefore, little difference between production and shipments in either 1947 or 1939.[12]

After analyzing the 1929 data for both shipments and production, Fabricant concluded that one-sixth of the industries were appreciably affected by the change in definition.[13] Even if shipment data were reported throughout, however, long-run trends would closely approximate production trends since positive and negative inventory changes tend to cancel out over time. In preparing production indexes for 1947 and 1954, the Census Bureau did adjust the shipments data for estimated changes in inventories of finished goods and goods-in-process.

Ideally, the current value of changes in inventories or goods-in-process should be included as part of the value of production. Acutally, this has been done by Census only in the case of long-lead time items, such as ships and aircraft. If it is assumed that goods-in-process generally tend to fluctuate with output, production trends should not be significantly distorted by the omission prior to 1947. During periods of expansion, however, census production figures would tend to be too small as goods-in-process are accumulated preparatory to and during a rise in output. The reverse would hold true in contractions.

The value of production includes not only commodities, but also certain services: contract work, custom work, repair work, and advertising. Contract work is important in only a few industry divisions, notably printing and apparel, but we deduct payments for contract work throughout in order to avoid duplication in the value-added estimates. Repair work is included by Census only when subsidiary to manufacturing operations. Custom work is reported only when acompanied by own-account work. Excluded are shipments of products that are made from materials owned by others, resold in the same condition as purchased, or returned to an establishment without sale.

[12] *Census of Manufactures, 1947*, Vol. I, p. 18.
[13] Fabricant, *The Output of Manufacturing Industries*, p. 343.

Census value of products does not include the value of research and development on own-account, nor construction undertaken within the establishment by the manufacturer's own force. From an economy viewpoint, additions or major alterations to plant, and possibly research and development as a form of intangible investment, represent final output. To the extent that the proportion of the work force engaged in these activities changes over time, while no allowance is made for the output involved, productivity movements can be distorted. The extent would probably be small in most industries, especially insofar as the investment is an offset to implicit depreciation.

Excise taxes were included in all censuses through 1939. While excluded from the 1947 and 1954 censuses, such taxes were reported separately for tobacco and other industries where important. We have added the excises back into the value of product in these years in order to provide a consistent basis for price deflation. In order to obtain unit factor weights, excise taxes were eliminated along with the value of purchased intermediate products.

In a dozen industries in 1947 and 1954, values of product and materials consumed were not shown. All these were industries in which the proportion of duplication between cost of materials and value of shipments exceeded 10 per cent. To provide continuity in the 1947 value estimates for deflation purposes, unpublished data were obtained from the Census Bureau for some industries; for the others, in which the ratios of cost of materials to value of product has been fairly stable, the 1939 ratio of value of product to value added was applied to the 1947 value added in order to obtain the full complement of value data.

Also to provide continuity, when industry definitions changed and overlapping value-of-product and cost-of-materials estimates were available, these value estimates were linked forward and backwards from 1937. Since the input estimates were similarly linked, consistency between the output and input estimates was maintained.

COST OF MATERIALS

The value of materials consumed represents the net cost, after discounts and allowances (paid or payable), of materials, parts, containers, fuel, and purchased electrical energy actually consumed during the year. Items that represent transfers from other establishments of the same company, or withdrawals from inventories, are included. Excluded are materials for sale in the same form as purchased and materials processed but not owned by the establishment, since these are not included in product.

Since 1935 for some industries, and since 1937 for all industries, the cost of contract work has been included by Census to arrive at a total cost of materials. To provide a consistent series throughout and reduce

duplication, we have adjusted cost of materials for all years prior to 1937 to include payments for contract work. To this extent, our value-added estimates for most industries differ slightly from those of Fabricant, who made such adjustments only in the case of industries in which contract work was important.

Excise taxes were included by the Census Bureau in cost of materials for 1931–37, a practice affecting primarily the tobacco and liquor industries. In line with the Fabricant procedure, these taxes were excluded from Census data in order to maintain consistency throughout. Value added and industry gross product for the affected industries thus include excise taxes. Exclusion of excises would make value added closer to factor cost, which as we noted in Appendix A, is to be preferred for weighting purposes. At the group level, national income originating, which excludes excises, was used as an alternative weighting system.

Not all "intermediate products" purchased by establishments for use in the production process are included by the Census Bureau in cost of materials. The omitted items are chiefly business services—insurance, advertising, communications, repair and maintenance by contractors, and purchased professional services. The influence of these omissions on the derived value-added estimates, as compared with factor cost, is noted in the next section.

VALUE ADDED

Value added in manufacturing is generally calculated by the Census Bureau by subtracting the reported cost of materials consumed from the total value of product. The main differences between value added and national income originating stem from the purchased intermediate products not deducted by Census (noted above) and, more importantly, from certain overhead items such as depreciation, rent, labor costs involved in maintenance and repairs, and indirect business taxes. However, a partial offset to the inclusion of these items in value added is provided, particularly since 1937, by the inclusion in income of employer contributions under the social security laws and of other supplements to wages and salaries. Many of the items excluded from national income but not from value added are ones that could only be obtained with difficulty, if at all, on an establishment basis; they are estimated for national income purposes on a company basis.[14]

The national income statisticians also adjust the income estimates for inventory revaluation. That is, inventory profits and losses are deducted from reported income, which includes the positive or negative book profits

[14] A rough item reconciliation between value added and national income was attempted by Fabricant for 1929 (*ibid.*, pp. 347–48). Adjusted census value-added estimates by industry, 1899–1937, are shown in the same volume.

estimated to have resulted from the charging of inventories to sales by methods other than replacement price. This puts national income estimates on a current market value basis.

In 1954, national income originating in manufacturing ran about 78 per cent of value added. For the twenty major industrial divisions, the ratios varied considerably around the mean value. Table D-3 shows that the ratio of value added to national income has varied somewhat over short periods, but has displayed little net trend since 1919. The correspondence is less close over the business cycle. Because of the relative inflexibility of overhead items, national income falls more rapidly than value added during business recessions, but advances more sharply during recoveries. If the national income estimates were unadjusted for inventory valuation, the fluctuations of the ratio over the cycle would be even larger.

TABLE D-3

Comparison of Census Value Added and National Income Originating in Manufacturing, Selected Years, 1919–54

	Census Value Added	*National Income*		*Ratio of National Income to Value Added*	
		Kuznets	Commerce	Kuznets	Commerce
	(billions of dollars)			(per cent)	
1919	23.3	16.2		70	
1925	25.2	16.8		67	
1929	30.1	19.8	21.9	66	73
1937	25.8		19.3		75
1947	74.4		58.7		79
1954	116.9		91.1		78

In weighting industry output measures and adjusting to group coverage, value-added estimates have been used since the theoretically more desirable factor cost estimates were not available. After 1929, in combining group output indexes to arrive at the all-manufacturing index, we tried national income weights based on the Commerce Department estimates. The results, shown later in Table D-7, were so close to those obtained by using value-added weights that we have adhered to the latter for the sake of consistency with the group estimates and of continuity with previous segment estimates.

As the Census Bureau long ago recognized, value added is in many ways preferable to gross value of product as a measure of production. In current prices, value added reflects changes in the relative prices of outputs and intermediate-product inputs, or the "terms of trade" of the industry. After correction for price change (discussed below) value added is a net output measure in that most duplication within and among

industries is eliminated. That is, only the processing of products purchased (or transferred) from other plants within the industry, or from other manufacturing or nonmanufacturing industries, is counted as the output of the industry in question. Real net output estimates consistent with national income, rather than value added, would be preferable. Again due to lack of data, we have had to be satisfied with real value-added estimates as a first approximation to the real net measure.

A saving of materials would show up as an increase in net output, but would not be reflected in gross output. An increase in quality due to a greater degree of fabrication would likewise affect the net measure but not the gross. Similarly, greater integration of fabricating activities, and a consequent reduction in materials purchases, would result in a rise in the net output measure along with a rise in inputs, whereas the gross output measure would be unaffected. Conversely, an increase in plant specialization would cause both net output and input to decline, while gross output would not reflect the change. For these reasons, net output measures are considered superior as a basis for productivity comparisons. Further, net, but not gross, industrial output and productivity measures are consistent with national product and productivity estimates.

Output Estimates

In general, the Fabricant indexes of the physical volume of output were used for 1899–1939, when available, and were linked in 1939 to indexes prepared by the Census Bureau in collaboration with the Federal Reserve Board and (in 1954) the Bureau of Labor Statistics (hereafter called the Census indexes) for extension to subsequent years. The methodology employed by Fabricant is summarized below and only significant modifications introduced by Census will be mentioned. Fabricant confined his indexes exclusively to weighted physical units, as did Census for 1947, with one exception. To some extent, we have extended or supplemented the physical-volume indexes wherever reasonably good price indexes were available for the deflation of the value of product. In preparing output indexes for 1954 relative to 1947, Census used price deflation techniques for all industries not covered by quantity data, even though broad imputations were required in some cases. These deflation procedures will be described as well as the broader deflation work necessary to arrive at net output measures, involving the adjustment for price changes of the cost of materials consumed as well as the value of product.

PHYSICAL VOLUME OF GROSS INDUSTRY OUTPUT

The industry indexes were calculated by weighting physical units of the various types of primary products issuing from the industry by their base-period unit values and adjusting for the degree of coverage as measured

by the ratio of the value of products entering the index to the total value of product of the industry. The various steps involved in this procedure have implications that will be made explicit.

Physical units and weights. The Census Bureau has long published partial data on the value and number of physical units of various types of goods produced as well as data on the total value of product by industry. Over time, the reporting of physical units has tended to expand, both in terms of the proportion of output covered and, particularly, in the degree of detail given for the various product classes. This may be readily seen in Appendix B of *The Output of Manufacturing Industries*, in which Fabricant presents the detailed data on quantity, value, and net realized price per unit underlying his output indexes as well as percentages of industry coverage—material not reproduced here but that will be of continuing value to the specialist. The corresponding data for 1939 and 1947 are shown in the Census monograph, *Indexes of Production.*[15] Only industry and product index numbers are shown in the more recent Census monograph for 1954.[16]

The continuing expansion of detail is indicated by the fact that the Census indexes for 1954 relative to 1947 are based on data for about 6,000 products, compared with 1,700 products in the 1947-39 comparison and 837 products in Fabricant's indexes for 1937 relative to 1929. The Census products covered 82 per cent of the total value of all manufactured products in 1954 and 60 per cent in 1947, while Fabricant's products covered 51 per cent. Including alternative methods of calculating the production indexes (primarily the use of materials consumed), the percentages of total value of product covered rise to around 66 and 55 for 1939–47 and 1929–37, respectively.[17]

Whenever possible, Census product data were supplemented by statistics from other sources, such as the Bureau of Mines, Department of Agriculture, Internal Revenue Service, and, occasionally, trade associations if their data appeared to be of good quality. In a few cases, non-Census data were used because they appeared superior to available Census data.

The unit in which production is measured was frequently dictated by the way in which the Census Bureau or other agency reported the data. Where a choice existed, the unit was selected which seemed most basic in the sense that the effect on unit value of shifts in the product mix would be minimized. It is important to keep in mind that the units are seldom indivisible. Since the units usually are more or less heterogeneous and comprise several product types or "qualities," each with differing unit

[15] *Census of Manufactures, 1947, Indexes of Production*, Chapter II and Appendix A.
[16] *Census of Manufactures, 1954*, Vol. IV, *Indexes of Production.*
[17] *Census of Manufactures, 1947, Indexes of Production*, p. 8; see also Table D–5, below.

value, shifts in the relative proportion of the various qualities of the product affect the unit values and not the quantity indexes as would be preferable. It is quite possible that over time, as real income rises, a net shift to higher qualities of products takes place, giving rise to a downward bias in the production indexes. Conversely, in contractions, there may be an upward bias as shifts to lower-value types of a product occur. Since the product detail underlying the indexes has gradually increased, this source of bias has diminished over time, although it is still present. In preparing the production index numbers for 1947–54, the Census Bureau substituted deflated value for weighted quantity measures in a number of instances in which comparison of unit value and price index numbers suggested a major degree of product shift.

TABLE D-4

Frequency Distribution of Manufacturing-Industry Indexes, by Percentage of Coverage of Physical-Units Data, Selected Years, 1909–47

Percentage of Coverage	*Number of Industries*			
	1909	1929	1939	1947
Below 40.0	0	1	6	8
40.0–49.9	3	5	5	10
50.0–59.9	3	4	11	12
60.0–69.9	1	10	16	19
70.0–79.9	8	24	25	28
80.0–89.9	8	28	43	35
90.0–99.9	24	46	67	64
100.0 and over	6	15	30	31
Total number of industries[a]	53	133	203	207

SOURCE: Figures for 1909 and 1929 (as well as for earlier census years not shown here) are contained in Solomon Fabricant, *The Output of Manufacturing Industries in the United States, 1899–1937*, New York (NBER), 1940, Table A-6, p. 353. Figures for 1939 and 1947 are taken from the *Census of Manufactures, 1947, Indexes of Production*, Table 4, p. 9.

[a] Not including industries for which the data necessary to make a coverage adjustment were not available, nor industries for which output indexes were based on methods other than that of weighting of physical units.

The availability of Census product quantity data varies considerably from industry to industry. In some industries, it was not feasible to collect product data; in others, data on most or all primary products were accessible; for most industries coverage varies between these extremes. Fabricant decided to prepare industry output indexes only if the value of the covered products primary to an industry were 40 per cent or more of the total value of industry output in most census years. As shown in Table D-4, a relatively small proportion of all industry indexes was based on coverage of less than 60 per cent. The Census computed several

indexes for 1939–47 based on less than the critical ratio in order to fill in group indexes, but these were not separately published. In the 1947–54 indexes, price deflation was used for industries in which the quantity data were inadequate.

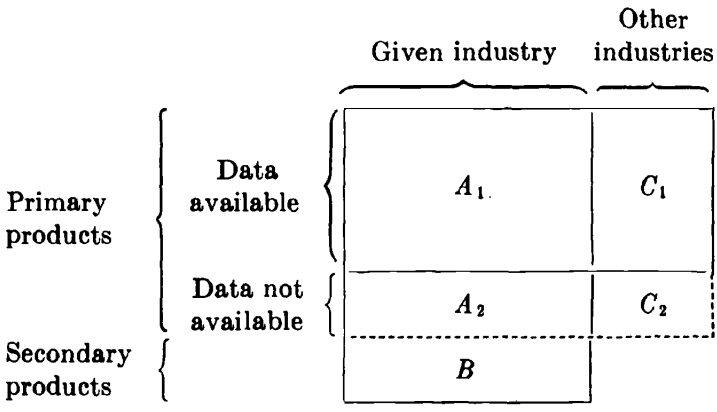
The standard procedure used to compute an "unadjusted" production index was to multiply the number of units of each type of commodity by the average unit value for the two years being compared—the Marshall-Edgeworth formula discussed earlier. Fabricant used 1909 as a base with which to compare 1899 and 1904; 1919, to compare 1909 and 1914; and 1929 as the base for the other census years through 1939. Although the Census Bureau computed the indexes for 1947 using 1939 and 1947 weights separately and as cross-weights, we used the latter to maintain consistency with the Marshall-Edgeworth chain for earlier years. Similarly, we used the Census Bureau's indexes based on cross-weights for 1947–54. Interpolation for 1953 and extrapolation to 1957 for the groups were done on the basis of the Federal Reserve Board production indexes.

Coverage adjustment. Adjustment for changes in coverage was needed because, in the various census years, the value of the products entering the raw index often fluctuated as a proportion both of the output of the primary products of the industry and of the total value of industry output including secondary products.

In terms of the following figure, the ideal output index would relate to all products of the given industry $(A + B)$, (where $A = A_1 + A_2$); actual data relate to $A_1 + C_1$, the primary products of the industry, wherever made. In real terms, $A_1 + C_1$ may vary as a proportion of $A + B$ if the coverage of the primary products $(A + C)$ varies; or if, with constant coverage of primary products, the proportion made outside the industry varies (C/A); or if the ratio of secondary products made in the given industry varies in relation to the primary products wherever made, $\left(\frac{B}{A_1 + C_1}\right)$. The current value coverage ratio would also vary if the prices of the uncovered-industry production $(A_2 + B)$ varied in relation to the prices of the primary products $(A_1 + C_1)$. It is possible, but unlikely, that the coverage ratio would remain constant as a result of divergent but offsetting price and quantity movements of $A_2 + B$ relative to $A_1 + C_1$.

In the absence of detailed price and quantity information regarding uncovered products $(A_2 + B)$, there are two feasible approaches to converting the product data to an industry basis. One is to assume that the physical volume of total industry output parallels the movement of covered primary production. This would imply that changes in the coverage ratio were due entirely to divergent price movements as between the covered-industry output (A_1) and the rest of the primary and secondary

industry output $(A_2 + B + C)$. On this assumption, the unadjusted indexes based on covered primary output would be used as they stand to approximate industry output.



The other approach is based on the assumption that the price movements of total industry output parallel the price movements of the covered primary output. The implication here is that changing coverage ratios are due to divergent quantity movements as between the covered industry output and the other primary plus secondary industry output. This approach necessitates the application of coverage adjustments to the unadjusted indexes.

It seems clear that the second approach yields more accurate results. As Fabricant points out, "prices probably move together within closer limits than do quantities, . . . the dispersion of prices in general is not very large; and within industries we may expect even less dispersion."[18] The Census analysts found that between 1939 and 1947 there was a significantly higher degree of correlation among price changes than among quantity changes as regards pairs of major and minor products for each industry.[19]

Both Fabricant and Census performed tests relating to 1929–37, and to 1939–47. The tests were set up slightly differently, but essentially they involved taking industries with high coverage ratios, deliberately discarding a portion of the quantity data, and then computing new industry

[18] Fabricant, *The Output of Manufacturing Industries*, pp. 364 and 366.
[19] *Census of Manufactures, 1947, Indexes of Production*, p. 97.

indexes on adjusted and unadjusted bases. The tests for both periods showed substantially better results by use of coverage adjustments. That is, the adjusted indexes based on a reduced amount of quantity data were closer to the indexes based on all the available quantity data than were the unadjusted indexes for the sample, in a substantial majority of industries tested.[20]

Instead of dividing industry output values by the weighted average price of covered primary products, a shorter method of adjusting for changing coverage can be used. It consists of computing coverage ratios for the base and given periods, converting the ratio for the given period to an index number relative to the base period, and then dividing the unadjusted index of physical volume by the derived factor. This method, originally developed by Frederick C. Mills, is mathematically equivalent to the deflation procedure[21] and was used by both Fabricant and the Census Bureau.

Obviously, the adjusted index is only an approximation to the true index of the physical volume of industry output. While it might be expected that prices of primary products made outside the given industry (C_1) would parallel the price movements of those made in the home industry, A_1 (and this correspondence would be affected by any differences in the composition of the two groups of primary products), there is less warrant for expecting prices of uncovered primary products (A_2) and particularly secondary products (B) to move with prices of A_1. An argument supporting the adjustment is that since technological advance in an industry tends to affect all branches of that industry, the relative costs and prices of the products involved would probably show less divergence than the prices of products picked at random.

In any case, the 40 per cent cutoff would limit the error. Taking the average true coverage in 1947 as 60 per cent (primary production averages 90 per cent of total value of industry output, and the coverage of primary production averages 66 per cent), a variation of 12 per cent in the average prices of uncovered products relative to the average prices of the covered products would result in an error in the adjusted physical-volume index of no more than 5 per cent.[22] For many industries, the potential accuracy of the indexes is higher, and accuracy should have increased somewhat over time as product coverage has increased. The increasing amount of product detail has also improved the quality of the implicit price deflation for uncovered value of output.

[20] For the detailed results of these tests, see Fabricant, *The Output of Manufacturing Industries*, pp. 366–69; and *Census of Manufactures, 1947, Indexes of Production*, pp. 97–98.

[21] The mathematical equivalence is demonstrated in Fabricant, *The Output of Manufacturing Industries*, p. 363. Cf. also *Census of Manufactures, 1947, Indexes of Production*, p. 96.

[22] Cf. Fabricant, *The Output of Manufacturing Industries*, pp. 364—66.

APPENDIX D

ALTERNATIVE METHODS OF ESTIMATING GROSS OUTPUT

The indexes for some industries, or groups of industries, were constructed by methods that do not use weighted physical units adjusted for coverage. Materials consumption was used for one group by Fabricant and for the same group, plus five other industries, by Census. Deflated value-of-product estimates were not used by Fabricant, and by Census only since 1947. We have used the latter approach up to 1947 to supplement and extend the previously published indexes wherever appropriate price series were available and the results seemed reasonable. The relative importance of the several methods, both before and after the supplementation provided here, is shown in Table D-5, which covers the first and last periods of the Fabricant index and extensions to 1947 and 1954. The substantial coverage, in terms of value added, of the supplementary deflated value series is due largely to the several indexes for 2-digit industry groups. The additional coverage contributed by the deflated value series at the 4-digit level was not large enough to warrant revising the original group indexes. However, these series add to the basis for industry analysis and are used in constructing a segment index for comparison with the previously published all-manufacturing index.

Materials consumption. Indexes of the physical volume of materials consumed are not generally to be recommended as substitutes for indexes of the physical volume of gross output, and even less for net output indexes. Insofar as the ratio of materials consumed to gross output (in real terms) varies, the former measure is biased as an approximation to gross output and is even less accurate as an approximation to net output, since by definition a change in the ratio of materials input to gross output produces a change in the opposite direction in the ratio of net output to gross output. Even when materials input could be readily estimated, this measure has only been used when quantity data or price deflators were completely lacking or seriously defective, and there was no reason to believe that the technical relationship between materials consumption and output had changed to a marked degree.

In printing and publishing, which accounts for most of the value added represented by materials indexes, materials consumption is represented by a few major types of paper, which were measured and weighted separately. As a proportion of total current value of product, the value of materials consumed showed little net change between 1899 and 1947. It can be inferred that the ratio between the real quantities has likewise been stable only if the ratio of final product prices to materials prices has not varied significantly. This cannot be learned directly since time series on average prices or rates in printing and publishing are not available. The fact that total productivity as measured here has increased somewhat

TABLE D-5

Types of Manufacturing Output Indexes: Number and Importance of Represented Industries, Selected Periods, 1899–1954

Method of Representation	*Number of Represented Industries*				*Importance of Represented Industries*			
	1947–54	1939–47	1929–37	1899–1904	1954	1947	1937	1899
					(per cent of value added)			
Total represented by specific indexes								
Excluding deflated value indexes	324	216	143	67	85.6	75.4	60.4	56.8
Including deflated value indexes	435	234	171	93	100.0	89.6	82.4	80.7
Product data	322	210	142	66	82.2	67.6	53.4	50.9
Materials consumed	2	6	1	1	3.4	7.8	7.0	5.9
Deflated value of products[a]	111	18	28	26	14.4	14.2	22.0	23.9
Not represented by								
Indexes other than deflated value					14.4	24.6	39.6	43.2
Any specific index					0	10.4	17.6	19.3
Grand total					100.0	100.0	100.0	100.0

[a] Up to 1947, the deflated value estimates have been prepared for the first time for this study, except for one index, representing 0.1 per cent of value added in 1947, which was used in Bureau of the Census comparisons for 1939–47. The deflated value estimates for 1947–54 were prepared by the Census Bureau and associated agencies. Of the 14.4 per cent of value added in industries so covered, 7.1 per cent was covered by the use of specific price indexes, while 7.3 per cent represents values deflated by group price indexes which involve the same possible errors as the coverage adjustments discussed in the text.

more rapidly in printing and publishing than in paper and paper products (and therefore prices have probably declined relatively) suggests that gross output and real value added may have risen somewhat more than materials consumption over the period. Such a development is not unusual in manufacturing industries, nor is it contrary to the impression that the degree of processing has tended to increase in printing and publishing.

Deflated value of product. Conceptually, deflated value estimates are not inferior to weighted physical output measures. If complete price and quantity data were available, the two approaches would yield identical results provided weighting systems were consistent. The choice between them, other things being equal, depends primarily on the relative degree of coverage of industry output. If different products were covered, the two approaches could be used to supplement each other within the same industry.

Since the coverage of product quantity data in manufacturing was generally higher than the coverage of price indexes and more readily assessable as to quality, Fabricant chose to use this approach consistently for all industries, with the exception of printing and publishing, although by adjusting for coverage he implicitly deflated the value of uncovered products by an average of the available unit value series. We have here accepted all the physical-volume indexes prepared by Fabricant and Census, but have supplemented these by deflated value series as prepared for this study up to 1947 (and as provided by Census since 1947). In some cases, deflated value series were used to represent industries or groups not covered at all by quantity indexes; in other cases, they were used to extend quantity indexes to years not previously covered.

In general, we have prepared deflators only if price series were available that represented types of primary products accounting for at least half the industry output. It should be noted that a considerable degree of imputation is involved in this criterion. It is assumed that the prices of the various unrepresented types of a product move with the price of the type which is specified by the price collection agency. In recent years at least, the Bureau of Labor Statistics, which is the source for most of the price series used, has investigated price movements extensively in order to make reasonable imputations and to shift specifications (with overlapping of the price series) if a given type of product becomes unrepresentative of the broader family. Prices are collected from at least three manufacturers in different areas of the country in an attempt to cover price movements nationally. Annual estimates are averages of monthly or quarterly observations.[23]

[23] For further description of the BLS wholesale price indexes, see *Techniques of Preparing Major BLS Statistical Series*, Bulletin 1168, 1954.

Assuming that the value-of-product estimates are relatively complete and accurate, the validity of the deflated value estimates depends primarily on the representativeness of the price samples underlying the deflators. Since that cannot be determined in the absence of information on average price movements of all the types of products comprising industry output, our selection of industries for which to present deflated value estimates was largely a matter of subjective evaluation. The price indexes comprising the deflators, together with their weights, are listed by industry in a Technical Note to this appendix. The user of the estimates is free to reject those deflated value and derived productivity series which he feels are based on inadequate price information.[24] The Census Bureau in its 1954 *Indexes of Production* used italics for those indexes believed to be of doubtful reliability.

Although the direct coverage of price indexes based on given types of a product is less than that of quantity indexes that are based on units comprising all types of a product, deflated value measures are not necessarily inferior to quantity measures. For if the physical units are relatively undifferentiated and price levels differ substantially among constituent types, the deflated value series has the advantage of reflecting shifts in the quality mix of the product family. Lack of information precludes quantification of these possibilities—they are mentioned to indicate that the degree of direct coverage is not the sole criterion as to the relative validity of deflated value versus physical-volume indexes; representativeness of the price series and homogeneity of the physcial units must also be appraised. In at least one group, food, a weighted average of available price indexes showed approximately the same movements between census years during 1899–1947 as the implicit unit value index. The correspondence could not be expected to be so close in most other groups, however, since both unit value and price data are generally not as adequate as in the food industries.

NET OUTPUT ESTIMATES

Our net output indexes for the food group measure the movement of the difference between Census value of product and cost of materials, etc., after deflation of each (see Table D-6). They thus represent real value added, which is somewhat grosser than real net product originating, as explained above. The estimates were constructed in terms of 4-digit industries or combinations of industries, corresponding, in general, to the

[24] We have presented deflated value series only if the resulting output and derived productivity relations seemed reasonable. As Arthur F. Burns has written: "There is, indeed, no more important check on the validity of conclusions drawn from statistical materials than the reasonableness of the results" (*Production Trends in the United States since 1870*, New York [NBER], 1934, p. 29).

classifications used in the 1947 interindustry study for which materials inputs by industry of origin were available.[25] We had hoped to carry out this approach for all manufacturing, but it proved to be so time consuming that only a pilot study was possible.[26]

TABLE D-6

Manufactured Foods: Gross and Net Output, Key Years, 1899–1947
(1929 = 100)

	Gross Output	Net Output[a]
1899	30.3	34.2
1909	44.9	40.5
1919	65.1	75.3
1929	100.0	100.0
1937	104.2	99.1
1947	158.6	166.4

[a] The net output indexes can be used in conjunction with the input indexes for the food and kindred products group shown in Table D-IV to calculate productivity ratios on this basis (cf. Table 53).

The general procedure followed was to deflate the adjusted value-of-product and value-of-materials series by the available price and unit value series. Thus, the real value-of-product estimates are essentially the counterpart of the physical output series described in the section above, except that in some cases where both were available, price indexes rather than unit value series were used for deflation. This made for consistency with the materials input series, which were usually deflated by components of the industry price deflators. In the case of the industries for which output indexes are not shown in the tables that follow, value of product was deflated either by less adequate price indexes or by an average of the price or unit value indexes used for the covered industries in the group. It was desirable to use full industry detail in order that the price of purchased-materials indexes for the group might have changing industry output weights.

Special tabulations from the BLS interindustry study for 1947 showed the purchases of each manufacturing industry, or group of industries, from all the other industries in the economy, exclusive of business services.[27] This

[25] *Industry Classification Manual for the 1947 Interindustry Relations Study*, Bureau of Labor Statistics, mimeo, June 6, 1952, revised March 20, 1953.

[26] Cf. the net output estimates made by the Bureau of Labor Statistics for selected years since 1939: *Trends in Output per Man-Hour and Man-Hours per Unit of Output—Manufacturing, 1939–53*, BLS Report No. 100, 1955.

[27] These tabulations were prepared by the BLS Division of Productivity and Technological Development for the purpose of estimating net output in manufacturing from 1947 to date; unpublished materials from the Interindustry Relations Study, 1947, were loaned to the National Bureau for use in this project.

distribution of materials inputs by industry of origin was necessary in order to obtain weights by which to combine the price indexes appropriate for the deflation of materials costs. In order to economize time, price indexes were not included for materials supplied by those industries which together contributed less than 10 per cent of total materials costs. Fragmentary data contained in earlier Census volumes were consulted so as to determine whether the relative importance of major material inputs had changed significantly over time. When this was the case, the weighting diagram for the materials prices was changed accordingly. Nevertheless, in the majority of industries, constant weights were applied to the price indexes. At the group level, however, changes in input composition due to changes in the relative importance of component industries are reflected in the input estimates and the implicit deflator.

Approximately two-thirds of the materials consumed in manufacturing industries come from within manufacturing. Since the majority of the price or unit value indexes employed to deflate value of product were also used to deflate materials cost, errors in the price deflators would, to a considerable extent, be offsetting for the manufacturing segment as a whole. For that reason, we show the net output indexes only for the manufactured foods group that we were able to deflate in some detail by price indexes judged to be of good quality. Even in the segment, errors in the price indexes that do not affect both product and materials—that is, prices of final products and of materials purchased from nonmanufacturing industries—will affect the real net output series, although over a broad area offsets are probable. Errors in weighting can also bias the results, but these are less important in the segment than in individual industries since changing industry composition is reflected in the broader segment measures.

OUTPUT ESTIMATES BY INDUSTRY GROUPS

The estimation of output indexes for the major groups and the whole manufacturing sector involved the same steps that underlie the basic industry indexes. The adjusted output indexes (or unadjusted indexes where adjustment is not feasible) are weighted together. Where industry coverage was not complete, but was sufficient to form the basis for a group index, a coverage adjustment was made to yield an adjusted group index. At the group level, the basis for weights and coverage adjustments is value added, instead of the value of product used at the industry level.

Weighting. In combining industry indexes by group, it was possible to employ value-added weights rather than the value-of-product weights, which are a less accurate approximation to factor cost. It should not be thought, however, that the application of value-added weights to gross output indexes yields a net output composite. Movements of the gross and

net indexes would be parallel only if the ratio of net to gross remained constant in the component industries, or if changes in the ratios were offsetting.

In combining the industry output indexes, the Marshall-Edgeworth formula may be used, substituting Q (the output index number) for quantities of products, and VA (value added) for prices. A shortcut formula used by Fabricant, and in a slightly different form by the Census Bureau,[28] yields results identical to those obtained by use of the modified Marshall-Edgeworth formula. It may be set down as follows:

$$\frac{\sum (VA_1 + VA_0Q_1)}{\sum (VA_0 + VA_1/Q_1)}$$

In the Fabricant formula, Q_1 represents the industry output index in the given year, relative to the base year as 100; subscripts $_0$ and $_1$ denote the base and given years, respectively. The cross-weighted indexes are chained together as of the terminal year in each subperiod, as in the case of industry indexes. It was this procedure that we used.

Group coverage adjustment. In several groups, the coverage of the adjusted industry indexes was complete, so further adjustment was not needed. In some groups, the missing industries were primarily those "not elsewhere classified," which generally produce commodities either not important enough to call for separate industry classifications or so highly diverse that the collection of meaningful quantity figures would require an inordinate amount of detail.

While Census had more than 40 per cent value-added coverage of industries in all groups for 1939–47, and full coverage for 1947–54, Fabricant fell short of this percentage in a number of groups and, therefore, did not calculate group indexes. Our supplementation of Fabricant's industry output indexes by deflated value estimates made possible the required coverage for these groups, with the exception of the instruments and miscellaneous group prior to 1929 and of rubber products prior to 1909.

There are more ways of coping with the problem of incomplete coverage at the group level than at the industry level. In addition to assuming that output or price movements in the missing industries are parallel to those in the covered industries, it is also possible to assume that unit value-added or output-per-worker movements are parallel. For the same reasons adduced in the industry discussion, the parallel output assumption may be discarded. As between the assumption of parallel movements of unit value or of unit value added, the latter is preferable. For unit values of industrial

[28] See Fabricant, *The Output of Manufacturing Industries*, p. 370; and *Census of Manufactures, 1947, Indexes of Production*, p. 11.

groups of products to move together, productivity, rates of factor compensation, and prices of intermediate products would have to change synchronously. Parallel movement of unit value added requires only that that the first two of these three elements move in like fashion. There is no reason to expect that prices of the different intermediate products purchased by different industries should move together. On the other hand, there is evidence (see Chapter 7) that factor prices tend to move together, at least over relatively long periods of time. Similarity of productivity movements among industries within a group may be greater than among groups insofar as the industries composing a group have technological similarities that facilitate the spread of particular innovations among their number. The assumption of parallel unit value-added movements was the one adopted by Fabricant. This involves computing coverage adjustment factors based on the ratio of value added in the covered industries to total group value added in the base and the given years.

Census, on the other hand, assumed for the 1939–47 indexes that output per worker in the missing industries of a group changed as it did in the covered industries. Investigation indicated that between 1939 and 1947, changes in output per man as among the industries of a group showed less variation than changes in unit value added. On the other hand, in a test similar to that used for the industry coverage adjustment described above, the two methods gave almost identical results. That is, experimental group indexes, calculated after discarding industry indexes accounting for about one-fourth of value added in the group, approximated the true group index (based on all available industry indexes) to about the same degree regardless of whether they were adjusted on the basis of value added or output per man. In the 1947–54 period, Census found less variation in both unit value and unit value added than in output perman among the industries of a group. For this period, they deflated the value of output of uncovered industries either by selected price deflators, or by the average price of output of the covered industries of the group.

The all-manufacturing index for 1947 relative to 1939 calculated from group indexes, with coverage adjustments based on output per man, is approximately 2 per cent higher than the composite index based on a unit value-added adjustment, and the latter is about 2 per cent higher than a composite of unadjusted group indexes. The differences between the two adjusted indexes are not great in the individual groups, with the exception of electrical machinery, for which the employment-adjusted index is significantly higher.

Since the several types of coverage adjustments are basically similar and yield generally comparable results, the Census indexes have been accepted since 1939 and linked to the Fabricant indexes. For the sake of strict consistency, the value-added adjustments would have been preferable for

the recent period. As already implied, however, both adjustments in essence rest on the assumption that productivity changes in the missing industries paralleled those in the covered industries in each group. Each adjustment is only a rough approximation to an application of this assumption. It could be argued that it would be more direct to compute productivity in each group as the weighted average of productivity in the covered industries. Then output changes could be obtained by applying the productivity change to the total group factor inputs. This solution was not feasible, however, since some of the data necessary to compute total factor productivity in the covered industries alone were not available.

ALL-MANUFACTURING OUTPUT

Alternative segment estimates. The output index for the manufacturing segment was calculated by combining the adjusted group indexes, using value-added weights, by the formula used to obtain the group indexes. In the period up to 1939 quantity indexes were lacking for several groups. To handle this problem, Fabricant combined the available group indexes, plus the several available industry indexes in the groups for which coverage was insufficient, and applied a coverage adjustment based on the ratio of value added in the covered groups plus additional industries to total value added in manufacturing. Here the assumption was that unit value added in the missing industries of the uncovered groups moved with unit value added in the rest of manufacturing. Fabricant also computed a segment index based on all available industry indexes and applied a coverage adjustment to this composite. This adjustment was naturally greater, since the group indexes used in the first instance had already been adjusted to cover missing industries. The results of the two approaches were not very different, the group method showing only a slightly lower trend rate of growth. The group method was considered preferable, however, since it is based on the plausible assumption that missing industries are better represented by the other industries of the groups to which they belong than by the covered industries in manufacturing as a whole.

To supplement the Fabricant indexes, we have computed an index for the segment using deflated value estimates for the missing groups through 1939. No coverage adjustment was needed from 1929 forward. Prior to 1929 an adjustment based on value added was used, but it was considerably smaller than Fabricant's. This broader index closely parallels the movements of the Fabricant index; but because of its already wide acceptance, we have employed the Fabricant index in our analyses. The alternative index may be considered as a rough check on the validity of the coverage adjustment employed in the quantity-based index. Another alternative index was computed for the period since 1929, using national income weights for the group indexes instead of value-added weights. Here again,

the differences are not large. Despite the theoretical superiority of national income weights, we have worked in terms of the index with value-added weights because of the availability of such weights prior to 1929 and the consistency of this index with the group indexes. The various output indexes just discussed are presented for comparison in Table D-7.

TABLE D-7

Alternative Estimates of Total Manufacturing Output, Selected Years, 1899–1957
(1929 = 100)

	Fabricant Indexes		*Fabricant Group Indexes Supplemented by Deflated Value Indexes*[a]	
	Average of Industries[b]	Average of Groups[c]	Value-Added Weights	National Income Weights
1899	25.1	27.5	27.3	
1904	31.4	34.2	33.8	
1909	40.3	43.4	43.5	
1914	48.5	51.1	50.8	
1919	60.5	61.0	63.5	
1921	51.9	53.5	52.9	
1923	77.5	76.9	76.7	
1925	81.7	81.9	81.4	
1927	86.5	87.1	86.3	
1929	100.0	100.0	100.0	100.0
1931	71.1	72.0	70.8	70.7
1933	62.3	62.8	61.2	60.9
1935	83.3	82.8	81.7	81.0
1937	104.5	103.3	103.2	102.2
1939		102.5	101.6	100.6
1947		178.3[d]	176.9[d]	175.6
1954		228.2[d]	226.4[d]	228.0
1957		264.6[e]	262.1[e]	260.6

[a] Index derived by combination of Fabricant's group indexes plus adjusted indexes including industry indexes based on deflated value of product where output coverage was not sufficient.

[b] Index derived by combination of adjusted indexes of individual industries. When adjusted indexes were not available, unadjusted industry indexes were used.

[c] Index derived by combination of adjusted indexes of groups plus adjusted indexes (or, if not available, unadjusted indexes) of industries not covered by groups. This is the index used in our study.

[d] 1939–54 extrapolated by output indexes published by Bureau of the Census.

[e] 1954–57 extrapolated by Federal Reserve Board index based on constant 1954 value-added weights.

Estimates prior to 1899. The Fabricant gross output index was extrapolated from 1899 back to 1869 by the index prepared by Edwin Frickey of Harvard University,[29] adjusted to include the output of leather and

[29] *Production in the United States, 1860–1914*, Cambridge, Mass., Harvard University Press, 1947, p. 54.

leather products and of stone, clay, and glass products. Since this index has been exhaustively described by its author, only a brief summary is in order here. Frickey collected quantity data relating to eleven of the fourteen major manufacturing groups, classified as in 1914. His annual interpolators covered ten of the eleven groups for 1899–79, but fewer groups in the earlier decade. Aggregates based on the smaller samples were linked to the larger aggregates to avoid distortion.

Weights were value added in 1899. Coverage adjustments were not used either within the groups or for the segment. Rather, segment weights were distributed proportionately to value added among the covered groups and, within each group, among the covered items. As noted earlier, the assumption of proportional movements of physical volume as between covered and uncovered items is less satisfactory than certain alternative assumptions. While Frickey's indexes have been accepted for the included groups, we have weighted into his index (again based on 1899 value added) the deflated value of product originating in the leather and leather products and the stone, clay, and glass groups, as estimated for census years by Creamer.[30] Frickey also omitted railroad repair shops; but this is desirable from our viewpoint since it is excluded from manufacturing by a later definition and we have excluded the corresponding inputs. The annual Frickey index was used for interpolations between census years.

The coverage of the Frickey index is substantially less than Fabricant's, and thus the estimates prior to 1899 must be considered to have a wider margin of error than those for subsequent years—particularly in view of the absence of coverage adjustments. Even from 1899 to 1914, which is the terminal year of Frickey's index, his coverage is less than that of Fabricant since he deliberately tried to base his index on production items available for the entire period plus items that emerged during the period. Despite the difference in coverage and method, the two indexes are not far apart during the period common to each. On an 1899 base the Frickey index in 1914 is 192, compared with 186 for Fabricant's, and half the gross difference may be explained by Frickey's omission of two major groups covered by Fabricant.

Annual interpolations. Because the Frickey index is more comprehensive than the Mills index used by Fabricant for interpolation of intercensal years from 1899 to 1914, it has been substituted as an interpolator for this period. The Fabricant interpolation based on Warren M. Person's index has been retained for 1914–19. After 1919, intercensal years have been interpolated by means of the Federal Reserve Board index of manufacturing production as revised since its use for the same purpose by Fabricant.

[30] Daniel Creamer, unpublished data prepared for *Capital and Output Trends in Manufacturing Industries, 1880–1948*, Occasional Paper, 41 New York (NBER), 1954.

Input Estimates

For most of the 4-digit industries for which output estimates are available, manhours have been estimated, but capital stock estimates are generally not available. Capital as well as labor input estimates are available for some industry subgroups, although frequently with a gap between 1929 and 1948. At the group level, both manhours and capital stock estimates are available for all our reference years.

In order to combine the two major classes of factor inputs, manhours were weighted by the base-period average hourly labor compensation, and real capital stock by the base-period rate of return on capital. Total input in the manufacturing segment is the sum of weighted factor inputs in the major groups. Because of the lack of complete detail for inputs below the group level, further internal weighting was not feasible.

Due to the various complications involved in estimating both employment and average hours worked, each of these variables is accorded a separate section below. A third section on labor input describes the sources of weights for the manhour estimates. The final section describes the sources of the capital stock estimates and the required weights.

EMPLOYMENT

The employment estimates for industries and groups are all based on data from the *Census of Manufactures* and are consistent with the output estimates as far as industry definitions are concerned. Classification discontinuities, whether adjusted for by linking overlapping estimates or, in some cases, left unadjusted, have been treated in parallel fashion in both the output and employment series. Problems remain to be considered primarily in connection with the comparability over time of the employment data.

Functional coverage. Troublesome questions arise concerning the scope of the employment estimates with respect to functional categories. Ideally, employment should include all persons engaged in the industry whose activity contributes to reported value added. A serious problem affecting continuity of the employment estimates concerns the extent to which distributive "nonfactory" personnel located at manufacturing plants were included in censuses prior to 1935. In 1935, a separate "Manufacturer's Distribution Report" was appended to the usual schedule; 520,000 persons were reported as engaged in distribution ("employees who devote all or the major portion of their time to distribution activities, such as selling, advertising, sales promotion, credit, billing, installing, or servicing goods sold, etc.").[31] Of these, 190,000 had been reported in the manufacturers' schedules. Thus, 330,000 persons, who were engaged in distribution within

[31] Fabricant, *Employment in Manufacturing*, p. 225.

the plant and whose productive activities were presumably included in the value of products, were excluded from the factory employment figures. In 1937 the distributive workers not reported on the manufacturers' schedules were requested. Only 170,000 additional employees were reported, which casts doubt on the comparability of the total figure with that for 1935. There is no reason to believe, however, that the factory employee total for 1937 is not comparable with 1935. In 1939, a separate report was requested for total distributive employees (and certain other categories), and 586,000 were reported. Since this figure is higher than the 520,000 reported in 1935, while the factory employment estimate proper is lower in 1939 than in 1935, it is "likely," as Fabricant pointed out, that employees formerly reported as factory workers were moved into distribution and the other new categories. All distributive workers in the plant were also included in the 1947 and subsequent Census reports, and the more restrictive "factory" worker definition was dropped.

Our procedure has been to treat the factory worker estimates as basically comparable over the entire period through 1937, although there were probably some fluctuations in the proportion of nonfactory workers included.[32] Since, as indicated, the total establishment employment estimates for 1939 and later censuses appear comparable with the 1935 total, we have linked the 1939 total to the 1935 total employment series. (Total employment indexes for the census years 1935–39 are given in the footnotes to Fabricant's tables.)[33] This procedure results in estimates for the groups and segment which are almost identical in movement with those of the Office of Business Economics (OBE) for 1929–39, although a different method of adjustment was used. In essence, OBE used a continuous and consistent series for clerical and administrative employees to extrapolate back the 1939 estimate of all salaried workers, including those engaged in distribution.[34]

Workers engaged in routine maintenance and repair have been included in factory worker data throughout. It is not certain to what extent force-account construction workers engaged in major alterations or additions to plant were included prior to 1939. In 1939 and the subsequent census, these workers were definitely included. The estimates including construction workers for 1939 and later were treated as comparable with those of earlier years. Since the 70,000 workers on force-account construction in 1939 constituted less than 1 per cent of manufacturing employment, possible lack of complete comparability with earlier years is not serious.

[32] See Fabricant's discussion of the various Census questionnaires in this regard (*ibid.*, Appendix A).

[33] *Ibid.*, Table F-1, pp. 264–330.

[34] See "Section on Wages and Salaries and Employment," *Technical Notes, Sources and Methods Used in the Derivation of National Income Statistics*, National Income Division, Office of Business Economics, mimeo, 1948.

Actually, the value of force-account construction work should be counted as capital formation, and included (net of depreciation) in output, if the workers are to be included in employment. To the extent that new construction is merely an offset to depreciation, the inclusion of construction inputs is consistent with output measures gross of depreciation.

Finally, there is the problem of persons employed in central administrative offices (C.A.O.) and other auxiliary establishments. A central administrative office is defined as "an office which operates two or more manufacturing plants, one or more of which are located in cities other than that in which the administrative office is located."[35] Since these workers contribute to the value of product of the associated establishments, they should be included in the employment figures. If all associated establishments were classed in the same industry, total C.A.O. employment could be included; otherwise, a problem of allocation arises. Actually, in all censuses from 1909 through 1925, C.A.O. employees were allocated by the Census Bureau to individual plants, usually on the basis of the relative value of product, and these numbers were included in the salaried-worker figures for the respective industries. In 1929, 1937, and 1939, data were collected but not shown, except for total manufacturing. In 1935 and 1947, data were collected but not tabulated. Since it is impossible to construct estimates of employment including C.A.O. employees by industry and group after 1925, employment in manufacturing establishments proper has been used from 1925 forward, and was linked in 1925 to employment including C.A.O. employees, which goes back to 1909; prior to 1909 employment is again strictly on an establishment basis. In effect, we are assuming that, except for 1909–25, C.A.O. employment is proportional to other industry employment. Since the proportion for all manufacturing changed from 0.94 per cent in 1925 to 1.31 per cent in 1937, any distortion in the secular movement of the total employment series for industries and groups should be minor and may take the form of a slight downward bias.

Employment in other auxiliary establishments is not included in our estimates, and generally this seems proper. The value of the services of sales branches and related warehouses is not included in the industry value data, since values are computed as of the time of shipment from the plant. Establishments producing services, such as power plants or repair and maintenance depots, presumably charge the consuming establishment in the firm accordingly; so the value of the services neither enters into value added nor affects changes in the value of product. Technical and supporting personnel engaged on research and development in separate laboratories should generally not be included in the employment estimates

[35] *Census of Manufactures, 1925*, Chap. IV.

since their work, for the most part, is not immediately related to current output. The 1954 Census was the first to present information on these auxiliary activities.

Class of worker. In line with our principle of taking account of total employment, the indexes are based on the sum of persons engaged in the several classes of work distinguished by the Census: wage earners (or "production workers" after 1939), salaried employees, and proprietors and firm members. Where available, we used the total employment indexes through 1939 prepared and described by Fabricant[36] (with the shift from a factory to a total basis in 1939 linked, as explained above). All series were extended by the total employment estimates presented in subsequent censuses for the same industry or most nearly comparable industry or group, as indicated on the tables to follow.

In the case of the several industries or groupings of industries for which employment indexes are given here but not by Fabricant, we constructed indexes based on his underlying data, published and unpublished.[37] The same adjustments were made as by Fabricant. In connection with the break caused by the exclusion after 1919 of establishments with value of product of $500 to $5,000, Census data made possible an overlap only in the case of wage earners. In this case, the data were linked and the later series extrapolated back by the earlier. The data on salaried personnel were not adjusted since few such persons were employed in small establishments and the series would be little affected by the break. Estimates for 1919 of the number of proprietors of establishments with a value of product over $5,000 were made by Fabricant, and these furnished the basis of our link for this class of worker. It should be noted, however, that since the minimum size of establishment included in censuses was, until 1947, based on value of product, the numbers of establishments and, thus, of proprietors and firm members were affected by significant changes in prices or in scale of operation. This undoubtedly introduced some distortions into the series on proprietors and firm members, but these persons were a small part of total employment in most manufacturing industries.

Although the wage earner classification was always based on the character of work done rather than the basis of compensation, the shift to a production worker definition in 1947 introduced some incomparabilities between the 1939 and 1947 estimates, particularly in certain industries. Since our indexes are based on total employment data, this modification

[36] *Employment in Manufacturing*, Appendix F.

[37] *Ibid*; wage earner data by industry are published in Table B-1. Worksheets available at the National Bureau contain the industry estimates for salaried workers, proprietors and firm members, and nonfactory personnel (1935–39) underlying the estimates shown for major groups in Tables B-2, B-3, and B-4.

of the definition of a particular class of worker does not affect the series. Prior to 1947, the employment estimates for wage earners represented annual averages in the sense of an average of monthly figures, each generally relating to the week which included or was closest to the fifteenth of the month. For salaried workers and for proprietors and firm members, the Census presented data relating only to one day, usually December 15. No adjustment was made to the basic data for this; thus, the annual index numbers of total employment may be slightly distorted by cyclical influences.

Because of our exclusive reliance on total employment, we have made some adjustments not needed by Fabricant. For 1899 Fabricant did not show an index number for total employment by industry because the available figures on proprietors and firm members covered hand trades and custom establishments, excluded from later censuses. We have extrapolated the total employment index from 1904 back to 1899 by the movement of the index numbers for wage earners only. Although the two indexes show virtually the same movement for all manufacturing,[38] it should be realized that the movement of the industry total employment series from 1899 to 1904 is not based on complete data and is, therefore, subject to an additional margin of error. In 1931, Census did not collect data on salaried workers. The movement of the total employment index was interpolated between 1929 and 1933 by the movement of the wage earner index; so the same restrictions attach to the 1931 figure as to that for 1899. However, the added margin of error cannot be great in either case because of the preponderant influence of wage earner employment on the total.

Segment totals. Prior to 1947, our output estimates by industry and group are available only for census years, but annual estimates were derived for all manufacturing. Thus, it was desirable also to obtain annual employment estimates for the segment.

From 1929 forward, the carefully prepared OBE series was available. Rather than use it to interpolate our census-year employment estimates, we adopted it as our basic series. It is true that the OBE estimates are a little higher than ours. This is because they are based on comprehensive Social Security data since 1939, which have been extrapolated by Census data and interpolated primarily by BLS estimates, and they thus include small-firm and C.A.O. employment. But the movements are virtually identical, with the exception of those for 1939–47, when the OBE series shows about a 1.5 per cent increase over the Census series. In any case, it is not clear that the Census series is more consistent with the output estimates than are the presumably comprehensive estimates of OBE,

[38] *Ibid.*, Table B-5.

since, for example, C.A.O. employment should be included in an employment series designed to be comparable with output. Rather than have two different series for total manufacturing employment, one purporting to be comprehensive and the other to be more closely comparable to the output series (which is doubtful), the comprehensive series was used for both purposes. It need only be remembered that the series is higher than, and its movements after 1929 slightly different from, the sum of the employment estimates for the twenty groups.

Prior to 1929, we extrapolated the OBE estimates by those of Fabricant. Between census years, the wage earner component was interpolated using BLS estimates for 1929–19[39] and estimates by Paul Douglas for the intercensal years 1919–1899.[40] The estimates of salaried employees were interpolated between 1929 and 1919 by the Kuznets series,[41] and for earlier years, on the basis of their relationship to wage earners and the ratio of manufacturing employment to labor force for census years 1919–37. The salaried-worker totals for 1929, 1927, 1904, and 1899 were adjusted upward to allow for C.A.O. workers not included in Census data for those years. Proprietors and firm members were interpolated between census years 1929–19 by the estimates of Kuznets,[42] and between census years 1899–1919, on a straight-line basis. At the segment level, the number of proprietors was raised by 10.6 per cent throughout to cover the estimated number of unpaid family workers, based on 1941 economy ratios (see Appendix A).

Independent estimates were made of manufacturing employment for census years prior to 1899 on a basis comparable to those after that date. The chief problem arose from the inclusion of neighborhood industries and "hand trades" in manufacturing prior to 1899. Beginning with the Census of 1905, which covered calendar-year 1904, persons engaged in these establishments were no longer canvassed, and the data for 1899 were adjusted for comparability. We have attempted to make comparable adjustments for 1869, 1879, and 1889.

For wage earners estimation for the early years involved four steps. First, wage earners in industries classified wholly as hand trades were eliminated.[43] Second, an adjustment was made for those industries which included some custom and neighborhood shops. Data for such shops were

[39] *Production-Worker Employment, Payrolls, Hours and Earnings in Manufacturing Industries, 1909, 1914–1938*, Bureau of Labor Statistics, mimeographed release L.S. 53-0902. These estimates are revised as compared with those used by Fabricant for interpolation.

[40] *Real Wages in the United States, 1890–1926*, Boston, Houghton Mifflin, 1930, pp. 438–439.

[41] Simon Kuznets, *National Income and Its Composition, 1919–1938*, New York (NBER), 1941, p. 600.

[42] *Ibid.*, p. 604.

[43] *Census of Manufactures, 1905*, Part I, p. cxv, lists these industries; most form Group 15, "Hand Trades," in *Census of Manufactures, 1900*, Part I, p. cxiv.

available in 1899.[44] The 1899 proportion of wage earners in custom shops to wage earners in all establishments in each industry was assumed to prevail back to 1869, and reported wage earner data were reduced accordingly. Third, wage earners in industries which Fabricant excluded for comparability with later censuses were omitted. Fourth, an adjustment was made to convert employment data to a full-year average basis. In the earlier censuses the average number employed during the time each establishment was in operation was reported, not the average for all months in the year.[45] This resulted in an overstatement of employment, chiefly in seasonal industries. An adjustment factor was derived by computing the ratio of the annual average to the average for months of high employment for industries in which a wide seasonal swing was evident.[46] The ratios for 1899 (the first Census for which monthly employment data were available) were used to step down the reported number of wage earners in seasonal industries in earlier census years. This adjustment is approximate, but 2 per cent or less of reported employment is involved. Table D-8 summarizes the derivation of estimates of the number of wage earners, consistent with the Fabricant estimates, for 1869–99.

The derivation of continuous and consistent estimates for proprietors and salaried workers prior to 1899 presented additional problems. In the Census of 1889 salaried workers were combined with proprietors and firm members. Prior to 1889, data on proprietors were not collected; and salaried workers, if reported at all, were included with wage earners. Furthermore, for proprietors, the 1904 Census did not retabulate 1899 data to exclude hand trades. So for 1899, Fabricant's estimate of proprietors and firm members[47] was accepted, and extrapolated back to 1869 by the number of establishments, a variable which we adjusted in the same manner as wage earners (except for the final seasonal adjustment, which would not affect the count of establishments).

The number of salaried workers for 1889 was estimated indirectly. The reported totals of proprietors and salaried workers in 1889 and in 1899 were available. Also available was the total in 1899 adjusted to exclude hand trades and the several industries excluded by Fabricant. The ratio of the adjusted figure to total reported proprietors and salaried workers in

[44] *Census of Manufactures, 1905,* Table 1, gives industry data for 1899 excluding custom and neighborhood shops. *Census of Manufactures, 1900,* Table 1, gives data including custom and neighborhood shops.

[45] *Census of Manufactures, 1900,* p. cvi.

[46] The standard used to determine seasonality in an industry was a doubling of monthly employment at some time during 1899. Consecutive months showing employment above the annual average were taken as the months of high employment, and a ratio (average of twelve months to average of months of high employment) was computed as the adjustment factor to apply to the active-period average employment estimates of earlier censuses.

[47] *Employment in Manufacturing,* p. 230.

1899 was extrapolated to 1889 by the change in the ratio of adjusted to unadjusted wage earner data. The 1889 adjustment ratio so obtained was applied to the reported total of proprietors and salaried workers. Salaried workers were computed as the difference between adjusted proprietors plus salaried workers in 1889 less proprietors (as previously estimated). For 1869 and 1879 salaried workers were extrapolated by adjusted wage earners. The extrapolation from 1889 to 1879 was made by industry groups; and from 1879 to 1869, by total wage earners since a group breakdown was not available.

TABLE D-8

Derivation of Estimates of Wage Earners in the Factory System, Decennial, 1869–99
(thousands)

	1899	1889	1879	1869
Wage earners reported in factory system by 1904 Census	4,715			
Wage earners reported in 1899 Census	5,308	4,252	2,733	2,054
Less: Hand-trade industries	623	559	245	234
Custom and neighborhood shops that were part of manufacturing industries	102	74	42	37
Overstatement due to reporting active-period averages		69	43	22
Plus: logging establishments[a]	130	143	68	69
Wage earners after adjustments	4,713[b]	3,693	2,471	1,830
Less: industries omitted by Fabricant	217	131	17	27
Final wage earner estimate	4,496[c]	3,562	2,454	1,803

[a] *Census of Manufactures, 1905*, Part I, p. xxix. Prior to 1904 no provision was made for treating logging operations conducted in connection with sawmill plants as a distinct and complete branch of the lumber industry. In the 1904 Census, data relating to the logging branch were first reported with comparable 1899 data. The ratio of wage earners including logging establishments to wage earners excluding logging establishments was applied to 1869–89 wage earner data in the lumber and timber products industry to estimate data for the logging branch of the industry.

[b] This differs by 0.04 per cent from the published Census figure based on retabulation of 1899 data.

[c] This agrees with Solomon Fabricant's series in his *Employment in Manufacturing*, p. 230.

Annual interpolations in the aggregate for 1889–99 were made on the basis of the Douglas estimates, also used for the subsequent period. Prior to 1889, annual estimates were interpolated on the basis of the relationship between total employment and output for subsequent years, using the Frickey series, which extends back. Since this is obviously a rough expedient, the estimates prior to 1889 are not shown on an annual basis, but only for census years. It is clear that the derived productivity estimates hinge on the estimates for the discrete census years.

AVERAGE HOURS WORKED

A large amount of data is available on the average hours of production workers in manufacturing industries. There are, however, several major problems involved in securing continuous series of actual hours worked; these will become apparent in the following description of sources and methods.

In general, our procedure involved using Census estimates of average actual hours worked per year for 1947 and subsequent years in the various industries, groups, and the segment as a whole. BLS estimates were primarily used in going back from 1947 into the 1930's. Unlike the Census estimates, the BLS series include hours paid for but not worked. This imparts a slight upward bias to the series, since time paid for but not worked increased perceptibly after 1940. Some BLS industry series are continuous back to 1923, and selected series prepared by the National Industrial Conference Board go back to 1914. In 1929 and prior years, however, chief reliance was placed on estimates of standard, or "full-time," hours scheduled in the various industries—based on Census distributions back to 1909, the *Nineteenth Annual Report of the Commissioner of Labor, 1904* and subsequent reports for 1890–1909, and the Aldrich Report (see note 54, below) in earlier years for all manufacturing. An adjustment factor was applied to these estimates to obtain actual hours worked. This factor is obviously a potential source of error. But since it is uniform for years of high-level activity, the trend in actual hours worked per week is determined by the trend in standard hours, which seems reasonable. Shorter-term movements may be affected, but we are chiefly concerned with trend.

The major source of possible error lies in the break in continuity occasioned by the shift from estimates of actual hours worked to the adjusted standard hours estimates. The adjustment factor expressing the ratio of actual to full-time hours is based on the BLS estimate for all manufacturing, which, in effect, is based on data for a sample of industries. Since the ratio undoubtedly varied among industries, some distortion is introduced in the movement of the series between 1929 and the first year of the 1930's for which estimates of actual hours worked were available.

Average actual hours, 1947 forward. Estimates of average hours actually worked per year, covering all manufacturing industries, are available only in the post-World War II period. Production worker manhour data by quarters were collected for the 1947 *Census of Manufactures* and annual totals for all industries were published. Only in the case of small establishments were manhours estimated indirectly. Plant hours worked were requested; excluded were hours paid for vacations, holidays, or sick leave, when the employee was not at the plant. Plant hours inevitably include

some idle time, but "stand-by" time is at the disposal of management. Comparable data were collected in the 1954 Census; for years commencing with 1949, the *Annual Survey of Manufactures* provides estimates, which are subject to relatively small sampling errors, for the larger industries and industry groupings.[48]

BLS estimates are also available for a large number of manufacturing industries in the postwar period, based on a sample covering more than 60 per cent of the employees in the industries canvassed. The BLS estimates, while also relating to production or nonsupervisory workers, comprise manhours paid for, whether worked or not. Hours paid for holidays, sick leave, and vacations taken are included. The period reported represents a pay period of one week ending nearest the fifteenth of the month. Since our theoretical objective was to estimate actual hours worked or available at the plant, the Census estimates were preferable, particularly in a period when the trend towards fringe benefits in the form of paid leave was important. The two series are compared in Table D-9.

TABLE D-9

Average Hours of Production Workers in Manufacturing, Comparison of Census and Bureau of Labor Statistics Estimates, 1947–57

	Census (1947 = 100)	BLS (1947 = 100)	Ratio: Census to BLS
1947	100.0	100.0	100.0
1948	n.a.	99.3	...
1949	96.9	97.0	99.9
1950	98.7	100.2	98.5
1951	99.0	100.7	98.3
1952	99.0	100.7	98.3
1953	98.5	100.2	98.3
1954	96.4	98.3	98.1
1955	98.2	100.7	97.5
1956	97.4	100.0	97.4
1957	96.4	98.5	97.9

n.a. = not available.

Throughout, the group average hours estimates are weighted industry average hours with production worker weights; the all-manufacturing average comprises the group averages weighted in the same fashion.

Average actual hours prior to 1947. In going from 1947 into the 1930's, the BLS estimates of average hours worked per week were used as the chief means of extrapolation. Fewer industries were covered than in recent

[48] Estimates for 1949–53, showing the standard error, are contained in *Annual Survey of Manufactures, 1953*, Bureau of the Census.

years, and the sample was smaller: 55 per cent of employees in 1940, 42 per cent in 1934, and 28 per cent in 1932 (the first year covered by the continuing BLS program). Some industries not covered by BLS were covered by special Census tabulations based on large-industry samples of average hours worked per month: 171 industries were included in 1939, 105 in 1937, 59 in 1935, and 32 in 1933. These estimates were employed in the years for which they were available. For a few industries, use was made of National Industrial Conference Board (NICB) estimates, which embody the same concept of average hours as the BLS series.[49]

In the case of a relatively small number of industries for which hours (as well as output) estimates were available for 1947 and 1929 but not for intervening years, an estimate for our key year, 1937, was obtained through interpolation by the index of average hours for the group. In the few cases in which the change in the group index between 1929 and 1947 was quite different from that of the industry index, the group movement from 1947 to 1937 alone was used. The change in average hours between these latter dates was generally small.

Prior to the BLS permanent program of estimating average hours and earnings, which began in 1932, continuous actual average hours estimates were available for a smaller group of manufacturing industries: 12 industries were covered in a series of special BLS surveys beginning in 1923, and 25 industries were covered by NICB, with the data starting in1914.[50] In most cases, the BLS series were used where available because the BLS samples were generally more adequate than those of the NICB (southern plants were under-represented in the latter). In a few cases, preference was given the NICB series when these seemed to show trends more consistent with available standard hours estimates.

Adjusted standard hours, 1869–1929. For the majority of industries in 1929 and earlier years, reliance was placed on estimates of standard hours per week, adjusted to approximate actual hours worked. The Censuses of 1909, 1914, 1919, 1921, 1923, and 1929 presented frequency distributions of wage earners by standard-hours classes for all manufacturing industries. We computed averages for each industry, group, and the segment, adjusted to our classifications. In all cases, the midpoints of the hours classes were used. Prior to 1919 the lower open-end class was 48 and under. The midpoint was determined by taking a weighted average of the greater detail available in 1919; the result was 46 hours. Similarly, a weighted average of the 1914 detail for the class intervals over 60 hours yielded an average of about 68 hours, which was used for 1919 and subsequent years.

[49] See M. A. Beney, *Wages, Hours, and Employment in the United States, 1914–1936*, New York, National Industrial Conference Board, 1936.

[50] These series are described and shown for the industries for which output estimates also are available in Fabricant, *Employment in Manufacturing*, Table C-2, pp. 236–43.

The assumed midpoint for the interval over 72 hours (74) was unimportant, since even in 1914 less than 1 per cent of wage earners worked more than 72 hours a week. In summary, the mean hours used for each class are shown in parentheses after the indicated class intervals: 44 and under (40); 44–48 (46); 48; 48–54 (51); 54; 54–60 (57); 60–72 (66); 72; over 72 (74).

Our average standard hours are slightly higher than those calculated by Brissenden who, for some reason, used mean values lower than the class midpoints.[51] Investigation of selected industries based on the more detailed BLS prevailing-hours data for 1914 indicated that mean values in these industries are not below the midpoints of the Census frequency distributions; if anything, they tend to be higher. The precise average standard hours figure is not important for our purposes, however, as long as the same method is used for all industries and the segment.

We adjusted the standard hours estimates for the various industries and groups on the basis of the ratio of the BLS actual hours estimates for all manufacturing to the standard hours estimates.

Since the adjustment from 1929 back depends on the BLS estimates of actual hours worked in the manufacturing segment, they will be described briefly.[52] From 1929 to 1923 the BLS estimates were based on the weighted average of estimates for twelve important industries, the industry estimates being obtained by dividing average weekly earnings by average hourly earnings. The ratio of average prevailing hours in these twelve industries to average prevailing hours for all manufacturing was computed from Census data as a basis for level and trend adjustments to the actual hours estimates. The 1929–32 movements were interpolated by the weighted average for the twelve industries. The 1922–20 movements were based on the estimates by W. I. King.

The BLS estimates for 1919, 1914, and 1909 were prepared by essentially the same method. Special studies had been made of average hourly earnings as follows: 27 industries were covered in 1919; 13 industries, in 1914; and in 1909, "several" important industries, with the results supplemented by occupational data for some additional industries. The average hourly earnings estimates were divided into average weekly earnings estimates for all manufacturing, based on Census data, in order to obtain estimates of average hours worked per week. It was felt that the indicated ratios of actual hours worked to prevailing hours were consistent with the relatively high level of scheduled hours then prevailing. Table D-10 shows our averages of prevailing hours in census years from 1929 back for all

[51] Paul F. Brissenden, *Earnings of Factory Workers, 1899–1927*, Census Monograph X, 1929, p. 352.

[52] See Technical Note, "BLS Historical Estimates of Earnings, Wages, and Hours," *Monthly Labor Review*, July 1955, pp. 801–806.

manufacturing and the BLS actual average hours estimates for 1909–29 as well as the further extrapolations described below.[53]

Our estimates would not correctly represent fluctuations in the ratios of actual to prevailing hours in the groups which differ from the sector in this respect. It is believed, however, that the trends of actual average hours based on prevailing-hours estimates are substantially correct. The main possible source of error lies in the movement of the actual hours estimates between 1929, when the adjusted Census average was last employed, and the year of the first available direct actual average hours estimate. That

TABLE D-10

Manufacturing: Prevailing Hours Compared with Estimated Actual Weekly Hours Worked, Selected Years, 1899–1929

	Prevailing Hours	Actual Hours	Ratio: Actual to Prevailing
1899	59.5	52.7	0.886
1904	57.9	51.1	0.883
1909	57.1	51.0	0.893
1914	55.4	49.4	0.892
1919	50.9	46.3	0.910
1921	50.3	43.1	0.857
1923	50.9	45.6	0.896
1929	50.4	44.2	0.877

is, assuming that the actual hours estimates are substantially correct as to level, the adjusted standard hours figures may not be fully comparable since the ratio of actual to prevailing hours may differ considerably among industries. The possible error is reduced for the groups, however, by offsetting errors in the components and by the fact that in most groups the actual average hours estimates for certain industries are based on the continuous BLS or NICB series. Space does not permit showing the industry detail, but the average hours estimates by industry can be calculated from the productivity summary tables. The continuous BLS or NICB series were extrapolated by the adjusted Census estimates from 1923 or 1914 back; if levels differed significantly, the level indicated by the former was preserved through a linking of the series in the earliest overlapping year.

[53] Some recent work that came to our attention after completion of the present study suggests that the BLS estimates of average hours worked in manufacturing may be too low from 1929 back. This is attributed to the fact that the BLS sample was over-weighted with large firms. If this is so, our manufacturing productivity estimates understate the true increase between 1929 and 1933. See Albert Rees, *New Measures of Wage-Earner Compensation in Manufacturing, 1914–57*, Occasional Paper 75, New York (NBER), 1960.

Extrapolation of the prevailing hours estimates from 1909 back to 1890 was accomplished by groups chiefly on the basis of the estimates contained in the *Nineteenth Annual Report of the Commissioner of Labor, 1904* and subsequent BLS reports extending these estimates; and from 1890 to 1869 for the segment, by the estimates contained in the Aldrich Report.[54] Since we are presenting detailed estimates only for the period beginning 1899, average hours by industries were not estimated prior to that date. Average hours were estimated by industry groups back to 1890, however, in order to obtain all-manufacturing estimates using group employment weights. Prior to 1890, the coverage of hours data is not broad enough to warrant the estimation of group averages and the all-manufacturing average is an employment-weighted average of the individual industries included in the Aldrich Report.

The average full-time hours estimates given in the *Nineteenth Annual Report* are unweighted averages of the average hours data for the various component occupational groups constituting the industry labor force. The occupational data were weighted by Leo Wolman's estimates of employment in the various occupations; and his industry averages were used—although, in most cases, they do not differ appreciably in movement from those given in the *Nineteenth Annual Report*.[55]

The use of the *Nineteenth Annual Report* and supplementary materials was somewhat complicated by the fact that whereas full-time hours are presented for 53 industries from 1890 to 1903, data for only 36 industries are continued from 1903 to 1907, and for only 19 industries between 1907 and 1909. The continuous industries presented no problem; if the estimates of the Census Bureau and the Labor Commissioner differed significantly in 1909, the Census level was accepted and the series linked. Even where the Labor series were not continuous, if the absolute levels of full-time hours in 1903 or 1907 appeared reasonable relative to 1909 (the same or higher, but not much higher than indicated by the mean change over the period), the series were accepted as comparable. Where this was not the case, the average movement for the continuous or comparable industries in the same group was used to bridge the gap, and the Labor series was linked to the level of the 1909 Census estimate so extrapolated. The averages for the groups in 1909 were extrapolated by the percentage changes in the averages for the employment-weighted component industries for which hours estimates were continuous or comparable. The extrapolation was done in three stages covering 1909–07, 1907–03,

[54] Bureau of Labor Bulletins 59, 65, 71, and 77; and *Report on Wholesale Prices, on Wages, and on Transportation*, Committee on Finance, Senate Report No. 1394, 52d Cong., 2d sess., 1893.

[55] We worked from Wolman's unpublished worksheets, at the National Bureau; but his estimates for selected years are published in *Hours of Work in American Industry*, Bulletin 71, New York, (NBER) 1938.

and 1903–1890, in order to make full use of the increasing amount of industry detail in these periods without affecting the level of the series. In the period 1890–1903, the coverage of the miscellaneous group was so small that the all-manufacturing average was substituted for the missing industries. In bridging the gap between 1907 and 1909 in several groups, the average movement for all manufacturing or an industry group which in other periods showed similar levels and movements had to be substituted. The period involved was so short and the average hours movements generally so slight that errors due to this expedient should be minor.

Since the census years 1869 to 1899, with the exception of 1879, were years of relatively good business, the movement of full-time hours for these years relative to 1909 was used to extrapolate the 1909 average actual hours estimates. Although there may have been differences in the ratios of actual to full-time hours in those years compared with 1909 due to trend or cycle factors, they were probably not large. Little or no trend movement is evident in the ratios for 1909–29. Whereas there is a cyclical pattern in the movement of average hours worked relative to full-time hours, the phases of the business cycle in these years were not different enough to warrant rough adjustment.

The situation is different in 1904, a year in which a business cycle trough occurred. For this census year, an adjustment factor was derived from the 1909–26 relationship between the ratio of actual to standard hours and the ratio of employment to labor force. The dependent variable was obtained by using the BLS actual hours series in conjunction with Douglas' annual estimates of full-time hours. The independent variable was obtained by using Fabricant's employment series and Carson's estimates of the manufacturing labor force,[56] 1909, 1914, 1919, and 1929, with straight-line interpolations. The formula is $y = 67.5 + 0.2398x$; $r = +.77$. The computed ratio for 1904 yields an actual hours estimate of 51.1, only 0.1 hour higher than the 1909 figure, whereas estimated full-time average hours were 0.8 hour higher. This estimate is roughly verified by an analysis made by BLS.[57]

Finally, in order to obtain an annual series for output per manhour in the manufacturing segment as a whole, actual average hours worked per week were interpolated between census years prior to 1919 by using the calculated ratios of actual to standard average hours based on the formula

[56] Daniel Carson, "Changes in the Industrial Composition of Manpower since the Civil War," *Studies in Income and Wealth*, Vol. 11, New York (NBER), 1949, p. 47.

[57] Technical Note, "BLS Historical Estimates of Earnings, Wages, and Hours," *Monthly Labor Review*, July 1955, pp. 801–806. When Census average weekly earnings in 1904 are divided by the BLS seventeen-industry average of hourly earnings, the implied average weekly hours are 50.4. This figure is not published in the BLS historical average hours series, which begins in 1909, due to the conclusion: "It is probable, however, that the actual average of weekly hours in 1904 was no lower than in 1909. . . ."

given above. These estimates are undoubtedly better approximations to actual average hours than would be estimates based on full-time hours with no allowance for a cyclical factor. They are, however, not presented as an independent series but only as a component of the total manhours estimates for the segment.

TOTAL MANHOURS AND LABOR INPUT

Indexes of average hours worked by production workers, obtained as described above, were multiplied by indexes of total employment (persons engaged) in order to obtain indexes of total manhours worked in the various industries, groups, and the manufacturing segment. This procedure involves the assumption that average hours worked by nonproduction workers have moved with those worked by production workers. The assumption does not seem to be unreasonable as far as trends go, although there may be divergences of movement over short periods. It is certainly preferable to make the assumption than to deal with production worker manhours alone. The ratio of production workers to total persons engaged in manufacturing industries has shown a pronounced downward trend, declining from almost 90 per cent in 1900 to 78 per cent in 1953.

Despite the decline in the relative importance of production workers, they still account for the predominant part of manufacturing employment. Thus, some divergence between the average hours worked by production workers and by other persons engaged would not seriously affect the total manhour estimates. As a matter of fact, production workers include some salaried employees; so the latter group is not entirely unrepresented in the average hours estimates. Proprietors were so small a component of the total that no special adjustment was made for their average hours, although this was done in segments where they were an important part of the labor force.

It has been remarked that the BLS estimates of average hours worked in groups of industries are weighted by production worker employment. We have followed this procedure for the group estimates prior to 1929 and for subgroup estimates throughout, since it is simpler, consistent with BLS, and gives approximately the same results as the use of total employment weights.

Labor input was obtained by weighting group manhours worked by average hourly labor compensation. Manhours were computed for all groups in key years. This was done in order to obtain productivity estimates by groups, as well as to obtain estimates of labor input for all manufacturing by weighting group manhours. From 1929 forward, the average hourly compensation weights were obtained by dividing group labor compensation as estimated by OBE by OBE estimates of employees multiplied by our average hours worked per year. In the few cases in which

regroupings occurred, we had to allocate labor compensation by our standard groupings based on Census wages and salaries for the latter. For 1929 and earlier years, average hourly earnings estimates were derived from the Census estimates of wages and salaries and employment, and our average hours. The earlier figures thus do not take account of supplements to wages and salaries, but these were minor prior to 1929.

TABLE D-11

Manufacturing: Relative Weights of Manhour Indexes, by Group, Subperiods, 1899–1953
(per cent)

	1899–1909	1909–1919	1919–1929	1929–1937	1937–1948	1948–1953
Foods	10.1	9.7	9.5	9.2	8.9	9.0
Beverages	0.8	0.6	0.6	0.6	0.5	0.5
Tobacco products	1.2	1.0	0.9	0.9	0.9	1.0
Textile mill products	8.8	9.8	9.5	9.3	10.5	10.3
Apparel and related products	6.1	7.0	6.9	6.3	6.0	5.6
Lumber and products except furniture	4.5	4.5	4.5	4.1	4.0	4.3
Furniture and fixtures	3.9	3.7	3.7	3.6	3.6	3.6
Paper and allied products	2.6	2.7	2.7	2.8	3.0	3.1
Printing and publishing	7.7	6.8	7.1	7.7	7.3	7.1
Chemicals and allied products	4.2	4.0	4.0	4.1	4.2	4.4
Petroleum and coal products	1.4	1.5	1.5	1.8	2.1	2.1
Rubber products	1.7	1.8	1.8	1.9	1.9	1.8
Leather and products	3.1	3.3	3.1	2.9	2.9	2.9
Stone, clay, and glass products	3.8	3.5	3.7	3.6	3.4	3.5
Primary metal industries	8.8	9.0	9.0	9.2	9.0	9.2
Fabricated metal products	7.5	7.1	7.3	7.2	7.2	7.4
Machinery, nonelectric	9.4	8.9	8.6	8.9	8.9	9.0
Electric machinery	5.9	5.4	5.2	5.6	5.7	5.6
Transportation equipment	5.8	7.2	7.8	7.7	7.5	7.5
Miscellaneous and instruments	2.7	2.5	2.6	2.6	2.5	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

This procedure results in weighting manhours attributed to proprietors by the average hourly compensation or earnings of employees in the various groups. The relative percentage weights applied to the group manhour indexes are shown in Table D-11. The relative stability of the weights reflects the more or less proportionate movement of average hourly earnings in the various groups.

One final adjustment was necessary. The sum of manhours worked in the various groups, which underlies the weighted labor input estimates, is not precisely equal to manhours as estimated directly for all manufacturing.

Small discrepancies in movement occur because (1) from 1929 forward, our employment estimates are those prepared by OBE, which differ slightly from estimates based on Census because of their more comprehensive coverage and to slightly different methods of adjusting the Census employment estimates for consistency from 1939 to 1929, as noted earlier; (2) our weighted average hours series differs slightly from the BLS series because we used total employment weights at the group level. Also, from 1929 back, we used BLS and NICB average hours for available industries plus adjusted standard hours for the other industries in each group. In order not to introduce estimates of employment and average hours for all manufacturing that are slightly different from the presently published ones, we have used the manhours figures for the segment estimated directly and have adjusted our weighted labor input accordingly,

TABLE D-12

Manufacturing:
Labor Input Based on Alternative Methods of Weighting,
Key Years, 1899–1953
(1929 = 100)

	Manhours (unweighted)	Manhours (constant 1929 weights)	Labor Input (changing weights)
1899	60.5	57.2	57.6
1909	83.8	80.7	81.1
1919	105.1	104.8	105.1
1929	100.0	100.0	100.0
1937	88.4	89.5	89.4
1948	132.9	136.9	136.9
1953	148.5	155.8	155.8

i.e., by the ratio of the sum of the underlying manhours to the direct segment estimates of manhours. Thus, the labor input and manhours estimates for the segment are appropriate for the purposes of building up economy estimates, and they are only slightly inconsistent with the sum of the estimates for the major manufacturing groups. The segment manhour estimates were also used to interpolate the labor input estimates (after adjustment) between the census years for which group manhour estimates were made from 1929 back. This merely involves the assumption that the proportions of manhours employed in each group moved in a regular fashion between the census years concerned. The weighted and unweighted manhour estimates for the segment for key years, 1899–1953, are shown in Table D-12. Prior to 1899, labor input was extrapolated by the estimates of manhours worked in manufacturing as a whole.

CAPITAL STOCKS AND INPUT

Our estimates of real capital stocks in manufacturing are based largely on the estimates underlying Creamer's *Capital and Output Trends in Manufacturing Industries*. Since publication of this paper, Creamer has revised the estimates for 1948 and extended them to 1953.[58]

Group estimates. Creamer's estimates for 1919 and prior years are derived from data on the net book value of capital given in the *Census of Manufactures*, combined to achieve industrial comparability over time and adjusted for price change. His estimates for 1929 through 1953 are based on data for corporations, obtained from the Internal Revenue Service, adjusted for industrial comparability, raised to cover noncorporate establishments, and adjusted for price change.

The adjustment for changes in the price of industry fixed capital is made by use of a deflator comprising indexes of building costs and prices of machinery and equipment; inventories are deflated by wholesale prices of the output of the industry. The building costs and the machinery and equipment indexes are each constructed by use of the formula

$$D = \frac{\sum_{t=1}^{n} \left(\frac{t}{n} \times V_t \right)}{\sum_{t=1}^{n} \left(\frac{t}{n} \times V'_t \right)}$$

where D is the deflator; n is the length of life of the capital item; t varies from 1 to n; V_t is the current price value of investment in that item in year t; and V'_t is the value of investment in year t in 1929 prices, derived by deflating V_t by an appropriate price index. The factor t/n assumes that straight-line depreciation has been applied to the original cost of the capital items in deriving net book values. It is assumed that there are no price lags in the book value of working capital.

We have adjusted Creamer's estimates to eliminate financial capital items (cash, receivables, etc.), and to achieve better industrial comparability with our output and employment data. The former adjustment was relatively simple for 1929 through 1953, because the value of inventories were available separately in the Internal Revenue tabulations and could be segregated from other items of working capital. For 1919, the estimates of manufacturing inventories given in Moses Abramovitz' *Inventories and Business Cycles*[59] were used wherever the classification by Abramovitz

[58] *Capital in Manufacturing and Mining.*

[59] *Inventories and Business Cycles, with Special Reference to Manufacturers' Inventories*, New York (NBER), 1950.

coincided with our own. Inventories for earlier years were estimated by applying averages of the ratios of inventories to total working capital in 1919–48. Average ratios of fixed capital to total capital in 1904 and 1929 were used as a basis for interpolating the value of fixed capital in 1909, 1914, and 1919, when fixed capital was not reported separately in the *Census of Manufactures.*

The Creamer estimates of real capital stock were adjusted for industry comparability with our output indexes by applying the ratios of Creamer's value of output in current prices to the Census value of production consistent with our output estimates for the various industry groups in each key year.

Segment capital input. Indexes of real capital stock for the manufacturing groups were weighted by the average unit capital compensation in successive pairs of key years beginning with 1929, and the average 1929–37 weights were applied to earlier key years. Capital compensation was derived from the OBE estimates of national income originating by industry by subtracting labor compensation, including an imputed compensation for the labor of proprietors.

There was some difficulty in estimating capital compensation in 1929, since the OBE estimates for that year were based on consolidated corporate income tax returns. To allow for this element of industry incomparability, we estimated the percentage difference in fixed capital for an industry resulting from consolidated tax returns on the basis of data given in *Statistics of Income for 1934* of the Internal Revenue Service, and applied this percentage to the 1929 residual capital compensation figure.

The calculation of a fixed 1929-weighted capital input was a straightforward procedure. To obtain the shifting-weight measure, however, required more ingenuity, because of the changes in industrial classification that took place in the basic data from which OBE computed the national income measures. Adjustments were made to the 1937, 1948, and 1953 capital compensation estimates, based on the percentage deviation between indexes of total employment shown by OBE, which are presumed to be industrially comparable with the industry national income estimates and our own industry employment indexes. These adjusted industry capital compensation estimates were divided by the corresponding capital input indexes in order to obtain measures of changes in unit rates of return.

The industry group capital indexes were then combined, using these modified unit capital compensation estimates, by a variant of the Marshall-Edgeworth formula, in the manner described earlier. The relative weights in the subperiods are shown in Table D-13.

TABLE D-13

Manufacturing: Relative Weight of Real Capital Input, by Group, Subperiods, 1929–53
(per cent)

	1929–37	1937–48	1948–53
Foods	10.2	10.3	9.5
Beverages	1.3	1.6	1.3
Tobacco products	2.3	1.3	1.2
Textile mill products	7.7	12.4	9.4
Apparel and related products	3.0	2.4	1.9
Lumber and products except furniture	3.1	4.2	3.2
Furniture and fixtures	1.1	2.7	3.1
Paper and allied products	2.1	3.6	4.4
Printing and publishing	4.7	3.6	3.7
Chemicals and allied products	9.3	7.7	7.2
Petroleum and coal products	8.4	7.9	7.6
Rubber products	1.6	1.6	2.1
Leather and products	1.5	2.1	2.2
Stone, clay, and glass products	3.9	4.5	5.3
Primary metal industries	10.8	8.9	11.2
Fabricated metal products	4.2	5.7	5.3
Machinery, nonelectric	9.6	6.9	6.7
Electric machinery	4.6	3.8	4.3
Transportation equipment	7.9	6.6	8.2
Miscellaneous and instruments	2.7	2.2	2.2
Total	100.0	100.0	100.0

TOTAL INPUT

Total factor input in the manufacturing groups and segment was obtained by weighting the labor and capital input indexes by the average unit compensation accruing to each, estimated as described above. The relative weights of each factor in the segment as a whole are shown in Table D-14.

TABLE D-14

Manufacturing: Relative Weights of Labor and Capital Inputs, Subperiods, 1919–53
(per cent)

	1919–29	1929–37	1937–48	1948–53
Labor	76.8	77.9	75.5	77.0
Capital	23.2	22.1	24.5	23.0

Technical Note to Appendix D

Price Indexes Used to Deflate Value of Output of Manufacturing Industries

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 20	*Foods, exluding beverages*			
2042	Prepared animal feeds	1923–14	Bran	29
			Cottonseed meal	25
			Linseed meal	17
			Mill feedings	29
		1914–1899	Cottonseed meal	
2043	Cereal preparations	1925–14	Hominy grits	10
			Corn meal	10
			Oatmeal	30
			Flour, wheat	50
2051	Bread and other baking products	1921–14	Bread, Chicago	29
			Bread, Cincinnati	5
			Bread, New Orleans	5
			Bread, New York	56
			Bread, San Francisco	5
		1914–1899	Bread, Cincinnati	44
			Bread, New York	56
2052	Biscuits, crackers, and pretzels	1921–14	Soda crackers	50
			Sweet crackers	50
		1914–1899	Soda crackers	
2093	Oleomargarine	1923–14	Oleomargarine	
2094	Corn products	1904–1899	Corn meal, white	34
			Corn meal, yellow	34
			Corn starch	32
2096	Vinegar and cider	1939–1899	Vinegar, cider	
2098	Macaroni and spaghetti	1933	Macaroni	
Group 208	*Beverages*	1933–29	The price index for nonalcoholic beverages was used for this period enabling us to compute a 1929-base series	
2081	Beverages, nonalcoholic	1929–27	BLS subgroup, nonalcoholic beverages	
Group 22	*Textile mill products*			
2256, 2259	Knit fabric mills and knitting mills, n.e.c.	1935–33	Imputed unit price of knit goods group	
2281	Hats, fur felt	1933	Hats, fur felt, finished	70
			Hats, fur felt, unfinished	30
2882	Hats, wool felt	1933	Price index for hats, fur felt	
2292	Lace goods	1933	Imputed unit price of cotton group	
2295a	Artificial leather	1933	Artificial leather, heavy	75
			Artificial leather, light	25

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 22	(continued)			
2295b	Oilcloth	1933	Oilcloth, shelf	40
			Oilcloth, table	40
			Oilcloth, wall	20
2297a	Jute goods	1904	Jute, raw	
2297b	Linen goods	1904	Linen shoe thread	
2298	Cordage and twine	1904	Manila rope	50
			Cotton yarn	50
Group 23	*Apparel and related products*	1925–19	Creamer's index of BLS clothing prices	
		1919–1899	Shaw's indexes of clothing and personal furnishings	
2325	Hats and caps, cloth	1933	Caps, men's	50
			Caps, boy's	50
2381, 2382	Gloves, fabric, dress, and work	1933	Gloves (census unit price 1931 and 1935 interpolated by straight line)	
2382	Suspenders and garters	1933	Garters, children's	25
			Garters, men's	25
			Garter's men's, wide	25
			Suspenders, men's	25
2388	Handkerchiefs	1933	Cotton, men's	25
			Cotton, women's	25
			Linen, men's	25
			Linen, women's	25
Group 24	*Lumber products*			
3988	Morticians' goods	1947, 1933	Metal caskets	33
			Wood covered caskets	67
Group 25	*Furniture and related products*	1947–14	BLS group, furniture	
		1914–1899	Bedroom sets	74
			Bedroom chairs	4
			Dining tables	7
			Dining chairs	15
2515	Mattresses and bed springs	1939–27	Mattresses	62
			Bed springs	38
2562	Window shades	1947–27	Window shades	
Group 26	*Paper and allied products*			
264–269	Converted paper products	1939–1899	Imputed unit price of Group 26	

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 28	*Chemicals and allied products*			
2841	Soap and glycerine	1899	Export price of soap	
2861, 2862	Hardwood and softwood distillation	1933	Acetic acid	33
			Wood alcohol	34
			Pine oil	33
2882	Linseed oil mills	1933, 1921–14	Linseed oil	62
			Linseed meal	38
		1914–1899	Linseed oil	62
			Flaxseed	38
2886	Grease and Tallow	1947–14	Tallow, edible	10
			Tallow, inedible	70
			Bones, ground	10
			Tankage	10
		1914–1899	Tallow, inedible	
2894	Glue and gelatin	1921–1899	Export price of animal glue	
2895	Carbon black	1909–1899	Lamp black	50
			Bone black	50
			(Prices from *Oil, Paint, and Drug Reporter*)	
Group 30	*Rubber products*	1914–1899	Creamer's index based on BLS price of autos and crude rubber	
3011	Tires and inner tubes	1919	Tires and tubes	75
			Creamer's index of price of other rubber goods	25
3099	Rubber goods other than tires and shoes	1925	Rubber heels and soles	
		1925–21	Unit price of rubber heels, soles, and auto fabrics	
Group 31	*Leather and leather products*			
3121	Industrial leather belting	1947	Leather belting	
		1925–19	Unit price of sole and union leather	50
			Unit price of chrome sole leather	50
		1919–1899	Unit price of belting leather	
3151, 3152	Leather gloves	1933, 1925–23	Gloves, men's	75
			Gloves, women's	25
3192	Saddlery, harness, and whips	1947–14	Harness	
		1914–1899	Unit price of harness leather	

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 32	*Stone, clay, and glass products*	1923–1899	Combination of industry deflators described below and including the following industries which were not separately presented for industry study: 323, glass products made of purchased glass: 1925–1899, imputed price of glass group. 324, cement: 1899, cement and lime 325, structural clay products: 1909–1899, unit price of four brick series 326, pottery: 1923–1899, two dinner ware series 327, concrete: 1925–04, sewer pipe; 1904–1899, unit prices of four brick series 329, abrasives, etc.: 1909–1899 unit prices of four brick series	
3211 3221 3229	Glass	1923, 1921	Plate glass, 3–5 ft. Plate glass, 5–10 ft. Window glass, A Window glass, B Milk bottles, quart Mason jars, quart Mason jars, quart, self-sealing Mason jars, pint, self-sealing Mason jars, pint Tumblers Nappies Pitchers	10 10 10 3 9 9 8 8 8 9 8 8
3274	Lime	1933	Lime, common Lime, hydrated	50 50
	Wall plaster and board (part of 3272, 3275, 2612 in 1947)	1933	Board, plaster Board, insulation Plaster	17 50 33

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 32	(continued)			
2952	Roofing	1933	Roofing, prepared:	
			Individual	25
			Medium	25
			Slate surfaced	25
			Strip shingles	25
3231	Products of purchased glass	1947–27	Mirrors	50
			Glass subgroup (3211, 3221, 3229 above)	50
326	Pottery	1947–25	Dinner sets, semivitreous	13
			Dinner sets, vitreous	25
			Plates	6
			Cups and saucers	6
			Unit price of lavatories	10
			Unit price of water closets	25
			Unit price of flush tanks	15
		1925–14	Plates	50
			Teacups and saucers	50
Group 33	*Primary metal products*			
3341a	Secondary metals, nonprecious	1923–1899	Imputed unit price of Fabricant's subgroup: copper, lead, and zinc	
3341b	Secondary metals, precious	1939–1899	Gold	60
			Silver	10
			Platinum	30
3351, 3359, 3361	Nonferrous metal products, n.e.c.	1923–14	BLS group, nonferrous metals	
		1914–1899	Unweighted average of nonferrous metals in BLS and Aldrich reports	
3392	Wire drawing	1947–09	Annealed wire	50
			Copper wire	40
			Brass wire	10
3393	Welded and heavy riveted pipe	1947, 1923–14	Black steel pipe	
	Aluminum	1939–14	Aluminum ingot	
Group 34	*Fabricated metal products*	1939–1899	Fabricant's industries with output indexes combined with industries having deflated value indexes described below	

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 34	(continued)			
3411	Tin cans and other tinware	1925–14	Tin cans	
		1914–04	Unit price of tinning	
3421, 3422	Cutlery and edge tools	1947	Census output index for cutlery combined with deflated value index for edge tools	
		1939–27	Scissors and shears	50
			Carvers	6
			Knives and forks	6
			Axes	6
			Chisels	6
			Hatchets	6
			Planes	6
			Corn hooks and knives	14
		1927–1899	Carvers	25
			Knives and forks	25
			Chisels	25
			Planes	25
3423, 3424, 3425	Hand tools, n.e.c., files, and saws	1947–27	Angle bars	28
			Augers	5
			Hammers	8
			Vises	11
			Shovels	5
			Rakes	5
			Files	5
			Saws, crosscut	22
			Saws, hand	11
		1927–1899	Augers	8
			Hammers	9
			Vises	17
			Shovels	8
			Files	8
			Saws, crosscut	33
			Saws, hand	17
3431	Plumbers supplies, n.e.c.	1939–27	Water closets	16
			Lavatories	16
			Sinks	28
			Tubs, bath	36
			Tubs, laundry	4
		1927–14	Tubs	50
			Sheet iron	50
3432	Stoves and ranges	1935–1899	Gas stoves	38
			Coal stoves	29
			Oil stoves	31
			Electric stoves	2

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 34	(continued)			
3439	Oil burners and heating apparatus	1939–27	Boiler tubes	16
			Boilers, heating	44
			Boilers, range	6
			Radiation	34
		1927–1899	Boiler tubes	
3441	Structural and ornamental products	1937–1899	Structural steel:	
			Pittsburgh	50
			Chicago	50
3444	Sheet metal work	1947–14	Unweighted average of 15 price series	
		1914–1899	Unweighted average of 5 price series	
3481	Nails and spikes	1947–27	Nails	80
			Spikes	20
		1927–1899	Nails	
3489	Wirework, n.e.c.	1937–14	Wire, annealed	36
			Wire, galvanized barbed	14
			Wire, galvanized fence	14
			Wire, woven	36
		1914–09	Wire, barbed	14
			Unit price, wire	86
		1909–1899	Wire, barbed	
3494, 3495	Bolts, nuts, and screw-machine products	1947–27	Wood screws	11
			Stove bolts	16
			Machine bolts	15
			Plow bolts	15
			Track bolts	11
			Rivets, large	16
			Rivets, small	16
		1927–14	Wood screws	45
			Unit price of bolts, nuts, and rods	55
		1914–1899	Wood screws	33
			Unit price of steel bars	67
3497a	Tin foil	1937–25	Unweighted average of aluminum pig, lead pig, and tin plate	
3999a	Fire extinguishers	1939–27	Foam type extinguishers	33
			Soda and acid type extinguishers	67
Group 35	*Machinery, nonelectric*	1947–1899	Sum of 3 subgroups described below	
3522	Agricultural machinery except tractors	1947–14	BLS group index of farm machinery excluding tractors	
		1914–1899	Shaw's index of farm machinery	

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 35	(continued)			
357	Office and store machinery	1939–29	OBE deflator for office and store machinery	
		1929–27	Unweighted average of 6 price series	
		1927–1899	Shaw's index for industrial machinery	
	Subgroup: Foundry and machine shop products	1947–1899	Made up of 7 separately deflated industries described below	
	351 Engines and tractors		Engines	50
			1947–29: OBE deflator	
			1929–14: BLS prices of 3 engines and ICC index of steam and generating machinery	
			1914–1899: Shaw's industrial machinery index	
			Tractors	50
			1947–14: Three BLS series	
	354 Machine tools and accessories		1947–39: BLS standard machine tool index	
			1939–14: ICC metal and wood-working machinery index	
	3552 Textile machinery		1947–39: OBE deflator for special industry machinery	
			1939–27: BLS: 7 knitting machines	
			1927–19: Shaw's industrial machinery index	
	3491 Steel barrels		1947–39: One BLS series	
			1939–27: Three BLS series	
			1927–14: Steel sheets and iron pails	
	3561 Pumps		1947–39: BLS index for pumps (from general and auxiliary machines)	
			1939–27: Three BLS series	
			1927–14: Shaw's industrial machinery index	

(continued)

Technical Note to Appendix D (continued)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 35	(continued)			
	358 Service and household machinery		1947–29: OBE deflator for service and household machinery 1929–27: BLS: 7 series 1927–23: BLS: 3 series; and Shaw's industrial machinery index 1923–14: BLS: 2 series; and Shaw's industrial machinery index 1914–1899: Shaw's industrial machinery index	
	353, 355, 356 Foundry and machine shop products, n.e.c. (residual)		1947–29: OBE deflator for construction machinery, mining machinery, special industrial machinery, and general industrial machinery 1929–1899: Shaw's industrial machinery index	
Group 36	*Electric Machinery*	1939–29	OBE deflator for electrical machinery	
		1929–14	Unit price of phonographs	4
			Western Electric's price index for telephone and telegraph apparatus	10
			Shaw's price index for electrical equipment, less phonographs	86
		1914–1899	Shaw's index for electrical equipment	
Group 37	*Transportation equipment*			
372	Aircraft	1947–29	OBE deflator for aircraft based on index of average hourly earnings in aircraft and	50
			BLS price of metal products	50
		1929–19	Hourly earnings in all manufacturing	50
			BLS price of metal products	50
373	Ship and boat building	1947, 1935	OBE deflator for ship and boat building	

(continued)

Technical Note to Appendix D (concluded)

Census Code Number	Industry	Period Over Which Price Deflation Is Used[a]	Price Indexes Used (BLS wholesale prices unless otherwise indicated)	Relative Weights
Group 38	*Instruments and related products*[b]	1939–29	OBE deflator for instruments	85
			Eastman-Kodak price index for instruments excluding photographic supplies	15
3861	Photographic supplies	1939–09	Eastman-Kodak index of prices received for photographic supplies	
Group 39	*Miscellaneous manufacturing*[b]		No group output index was computed prior to 1939 because the industries for which output or deflated value was available did not adequately represent the uncovered industries	
3931	Pianos	1933	Unweighted average of 3 piano series	
3949	Sporting and athletic goods	1933, 1927	Unweighted average of 25 sporting-goods series	
3995	Umbrellas, parasols, and canes	1947–27	Umbrellas, women's	50
			Umbrellas, men's	49
			Canes, men's	1

NOTE: This tabulation relates to manufacturing industries for which quantity measures were either lacking or inadequate for the periods indicated, but for which value and price information were available and used to supplement the quantity measures.

[a] Where a single year only is indicated, obviously the price index was available also for adjoining census years, e.g. in the case of 1933, the index was also available for 1931 and 1935.

[b] Groups 38 and 39. Prior to 1939 an output index was constructed for all miscellaneous industries including instruments and related products by combining available quantity indexes for industries in groups 38 and 39 and using, for the uncovered segment, an output index derived by deflating value of product of the total miscellaneous group by the implicit price index for the manufacturing segment. The percentage of value added of the total miscellaneous group represented by industry output indexes was: 1899, 7 per cent; 1909, 16 per cent; 1919, 19 per cent; 1929, 36 per cent; 1929–39, 60 per cent; 1939–54, Census output indexes were available.

TABLE D-I

Manufacturing: Output, Inputs, and Productivity Ratios, Key Years, 1869–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Labor Input	Output Per Unit of Labor Input	Capital Input	Output Per Unit of Capital Input	Total Factor Input	Total Factor Productivity
1869	7.1	19.9	35.5	25.1	28.2	23.9	29.6	4.4	158.9	19.4	36.4
1879	10.2	26.6	38.3	32.8	31.1	31.2	32.7	7.6	134.6	25.7	39.7
1889	18.3	38.3	47.8	46.4	39.4	44.2	41.4	17.6	104.0	38.0	48.2
1899	27.5	50.8	54.1	60.5	45.5	57.6	47.7	29.3	93.9	51.0	53.9
1909	43.4	72.7	59.7	83.8	51.8	81.1	53.5	54.4	79.8	74.9	57.9
1919	61.0	100.3	60.8	105.1	58.0	105.1	58.0	92.9	65.7	102.3	59.6
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	103.3	101.2	102.1	88.4	116.9	89.4	115.5	85.4	121.0	88.5	116.7
1948	184.2	146.5	125.7	132.9	138.6	136.9	134.6	120.8	152.5	133.1	138.4
1953	243.4	164.9	147.6	148.5	163.9	155.8	156.2	153.7	158.4	155.2	156.8
1957	264.6	160.9	164.4	141.4	187.1	148.1[a]	178.7	n.a.	...	...	...

n.a. = not available

[a] Calculations made after revised data of the Office of Business Economics became available reveal that a detailed computation of labor input would give an index of 149.0, showing a fall of 4.4 per cent between 1953 and 1957 instead of the 4.9 per cent fall indicated in this table. The difference is so slight we have not corrected for it in the manuscript.

TABLE D-II

Manufacturing: Output, Labor Inputs, and Labor Productivity Ratios, 1869–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Labor Input	Output per Unit of Labor Input
1869	7.1	19.9	35.5	25.1	28.2	23.9	29.6
1879	10.2	26.6	38.3	32.8	31.1	31.2	32.7
1889	18.3	38.3	47.8	46.4	39.4	44.2	41.4
1890	19.7	39.9	49.4	48.4	40.7	46.1	42.7
1891	20.2	41.1	49.1	49.5	40.8	47.1	42.9
1892	21.9	43.6	50.2	53.1	41.2	50.6	43.3
1893	19.4	42.1	46.1	50.3	38.6	47.9	40.5
1894	18.8	40.0	47.0	46.4	40.5	44.2	42.5
1895	22.4	43.6	51.4	51.7	43.3	49.2	45.5
1896	20.4	42.7	47.8	49.8	41.0	47.4	43.0
1897	22.0	44.2	49.8	51.5	42.7	49.0	44.9
1898	25.1	45.4	55.3	53.1	47.3	50.6	49.6
1899	27.5	50.8	54.1	60.5	45.5	57.6	47.7
1900	27.7	52.8	52.5	62.8	44.1	59.9	46.2
1901	30.9	55.5	55.7	65.9	46.9	62.9	49.1
1902	35.5	60.4	58.8	72.2	49.2	69.1	51.4
1903	35.4	62.7	56.5	74.4	47.6	71.3	49.6
1904	34.2	59.1	57.9	68.4	50.0	65.6	52.1
1905	39.0	66.1	59.0	77.9	50.1	74.9	52.1
1906	41.6	69.6	59.8	81.9	50.8	78.9	52.7
1907	42.1	72.8	57.8	86.0	49.0	82.9	50.8
1908	33.7	65.2	51.7	73.6	45.8	71.1	47.4
1909	43.4	72.7	59.7	83.8	51.8	81.1	53.5
1910	45.1	76.0	59.3	88.2	51.1	85.6	52.7
1911	42.7	76.0	56.2	87.4	48.9	85.1	50.2
1912	51.3	79.4	64.6	91.3	56.2	89.2	57.5
1913	53.8	80.2	67.1	91.5	58.8	89.7	60.0
1914	51.1	77.4	66.0	86.5	59.1	85.1	60.0
1915	59.9	80.9	74.0	89.8	66.7	88.6	67.6
1916	71.2	95.4	74.6	108.6	65.6	107.5	66.2
1917	70.6	102.0	69.2	115.7	61.0	114.9	61.4
1918	69.8	104.0	67.1	114.6	60.9	114.2	61.1
1919	61.0	100.3	60.8	105.1	58.0	105.1	58.0
1920	66.0	100.1	65.9	107.3	61.5	107.3	61.5
1921	53.5	77.4	69.1	75.4	71.0	75.4	71.0
1922	68.1	84.7	80.4	84.7	80.4	84.7	80.4
1923	76.9	96.2	79.9	99.3	77.4	99.3	77.4
1924	73.4	90.2	81.4	89.2	82.3	89.2	82.3
1925	81.9	92.7	88.3	93.4	87.7	93.4	87.7
1926	86.2	94.7	91.0	96.4	89.4	96.4	89.4
1927	87.1	93.5	93.2	95.2	91.5	95.2	91.5
1928	90.1	93.8	96.1	94.2	95.6	94.2	95.6
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(continued)

TABLE D-II (concluded)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Labor Input	Output per Unit of Labor Input
1930	85.6	89.2	96.0	85.0	100.7	85.1	100.6
1931	72.0	75.6	95.2	69.3	103.9	69.5	103.6
1932	53.8	63.9	84.2	55.4	97.1	55.6	96.8
1933	62.8	68.9	91.1	59.4	105.7	59.7	105.2
1934	69.1	79.9	86.5	62.6	110.4	63.1	109.5
1935	82.8	85.1	97.3	70.4	117.6	71.0	116.6
1936	96.8	92.2	105.0	81.7	118.5	82.5	117.3
1937	103.3	101.2	102.1	88.4	116.9	89.4	115.5
1938	80.9	87.4	92.6	70.4	114.9	71.3	113.5
1939	102.5	95.5	107.3	81.5	125.8	82.7	123.9
1940	118.6	104.3	113.7	89.9	131.9	91.4	129.8
1941	157.9	125.7	125.6	115.5	136.7	117.6	134.3
1942	197.2	146.1	135.0	141.8	139.1	144.6	136.4
1943	238.1	166.3	143.2	168.9	141.0	172.5	138.0
1944	232.5	163.1	142.6	166.8	139.4	170.7	136.2
1945	196.5	145.5	135.1	142.9	137.5	146.5	134.1
1946	160.6	139.1	115.5	127.1	126.4	130.5	123.1
1947	178.3	145.9	122.2	133.3	133.8	137.1	130.1
1948	184.2	146.5	125.7	132.9	138.6	136.9	134.6
1949	173.5	136.1	127.5	120.7	143.7	124.8	139.0
1950	201.1	143.5	140.1	129.5	155.3	134.4	149.6
1951	214.3	154.4	138.8	139.8	153.3	145.6	147.2
1952	223.6	157.2	142.2	142.3	157.1	148.7	150.4
1953	243.4	164.9	147.6	148.5	163.9	155.8	156.2
1954	228.2	153.5	148.7	135.4	168.5	141.9	160.8
1955	255.9	158.6	161.3	142.4	179.7	149.2	171.5
1956	264.3	161.9	163.2	144.3	183.2	151.2	174.8
1957	264.6	160.9	164.4	141.4	187.1	148.1	178.7

TABLE D-III

Manufacturing, Durable and Nondurable: Output, Inputs, and Productivity Ratios, Key Years, 1899–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Labor Input	Output Per Unit of Labor Input	Capital Input	Output Per Unit of Capital Input	Total Factor Input	Total Factor Productivity
					DURABLE GOODS[a]						
1899	25.0	48.8	51.2	57.5	43.5	53.3	46.9	25.7	97.3	47.0	53.2
1909	39.6	70.3	56.3	79.7	49.7	75.2	52.7	53.5	74.0	70.2	56.4
1919	61.7	102.7	60.1	106.4	58.0	105.9	58.3	90.5	68.2	102.4	60.3
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	92.0	98.0	93.9	86.0	107.0	86.7	106.1	82.9	111.0	85.9	107.1
1948	178.7	155.2	115.1	138.2	129.3	141.7	126.1	117.0	152.7	136.1	131.3
1953	262.9	188.3	139.6	168.6	155.9	176.3	149.1	159.6	164.7	172.5	152.4
1957	270.1	183.4	147.3	160.3	168.5	168.1	160.7	n.a.	...	...	...
					NONDURABLE GOODS[b]						
1899	29.6	53.2	55.6	63.4	46.7	61.9	47.8	32.7	90.5	54.1	54.7
1909	47.2	75.8	62.3	85.9	54.9	85.0	55.5	55.2	85.5	77.1	61.2
1919	60.3	99.0	60.9	99.4	60.7	99.6	60.5	95.2	63.3	98.4	61.3
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	113.9	104.5	109.0	85.9	132.6	87.1	130.8	87.7	129.9	87.2	130.6
1948	184.5	133.2	138.5	115.9	159.2	119.6	154.3	124.2	148.6	120.9	152.6
1953	218.1	136.2	160.1	116.1	187.9	121.0	180.2	147.4	148.0	127.8	170.7
1957	246.3	133.4	184.6	112.3	219.3	118.4	208.0	n.a.	...	...	...

n.a. = not available.

[a] The durable subgroup (following the classification of the Board of Governors of the Federal Reserve System) includes nine Census groups: lumber products; furniture; stone, clay, and glass products; primary metals; fabricated metals; machinery, nonelectric; electric machinery; transportation equipment; miscellaneous, including instruments and related products.

[b] The nondurable subgroup includes eleven Census groups: foods; beverages; tobacco products; textile mill products; apparel; paper and products; printing and publishing; chemicals; petroleum and coal products; rubber products; leather and products.

TABLE D-IV

Manufacturing: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1899–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Capital Input	Output Per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				FOOD AND KINDRED PRODUCTS (excluding beverages)					
1899	30.3	45.1	67.2	54.3	55.8	35.1	86.3	50.3	60.2
1909	44.9	65.3	68.8	76.1	59.0	57.1	78.6	72.1	62.3
1919	65.1	104.6	62.2	110.0	59.2	106.8	61.0	109.3	59.6
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	104.2	108.7	95.9	96.7	107.8	79.7	130.7	92.6	112.5
1948	154.5	134.6	114.8	122.1	126.5	100.7	153.4	116.9	132.2
1953	170.7	136.0	125.5	119.4	143.0	104.9	162.7	115.9	147.3
1957	188.4	136.6	137.9	119.9	157.1	n.a.	...	...	...
				BEVERAGES					
1899	295.9	151.1	195.8	184.6	160.3	170.7	173.3	178.3	166.0
1909	433.6	219.3	197.7	236.6	183.3	239.5	181.0	237.9	182.3
1919	158.9	163.6	97.1	167.7	94.8	140.2	113.3	155.3	102.3
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	684.9	254.5	269.1	233.1	293.8	200.9	340.9	220.9	310.0
1948	1,342.5	406.4	330.3	389.7	344.5	315.2	425.9	359.0	374.0
1953	1,391.6	395.2	352.1	362.0	384.4	345.1	403.2	356.0	390.9
1957	1,473.7	323.7	455.3	282.4	521.8	n.a.	...	...	...

(continued)

TABLE D-IV (continued)

TOBACCO PRODUCTS									
1899	29.8	113.7	26.2	128.5	23.2	20.9	142.6	83.3	35.8
1909	43.4	144.0	30.1	157.2	27.6	38.1	113.9	107.2	40.5
1919	69.3	133.7	51.8	139.4	49.7	60.7	114.2	106.3	65.2
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	117.2	77.0	152.2	65.4	179.2	80.0	146.5	71.7	163.5
1948	185.8	64.3	289.0	56.5	328.8	136.6	136.0	83.9	221.5
1953	203.3	66.8	304.3	58.9	345.2	146.4	138.9	88.7	229.2
1957	212.7	59.2	359.3	50.9	417.9	n.a.	...	...	...
TEXTILE MILL PRODUCTS									
1899	40.8	60.8	67.1	70.9	57.5	49.6	82.3	67.1	60.8
1909	60.7	80.9	75.0	91.9	66.1	76.4	79.5	89.1	68.1
1919	71.1	95.5	74.5	90.6	78.5	115.1	61.8	95.0	74.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	108.1	100.3	107.8	76.8	140.8	71.1	152.0	75.7	142.8
1948	161.5	106.7	151.4	89.0	181.5	78.5	205.7	86.6	186.5
1953	168.4	92.9	181.3	76.5	220.1	87.8	191.8	78.9	213.4
1957	168.2	78.7	213.7	64.0	262.8	n.a.	...	...	...
APPAREL AND RELATED PRODUCTS									
1899	30.4	53.8	56.5	68.3	44.5	29.4	103.4	63.2	48.1
1909	50.8	87.2	58.3	104.3	48.7	57.6	88.2	98.2	51.7
1919	64.2	95.0	67.6	94.8	67.7	95.1	67.5	94.8	67.7
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	103.9	109.1	95.2	87.9	118.2	66.7	155.8	85.3	121.8
1948	154.0	152.9	100.7	137.3	112.2	132.4	116.3	136.5	112.8
1953	171.0	160.7	106.4	140.1	122.1	161.6	105.8	141.8	120.6
1957	180.3	155.7	115.8	133.1	135.5	n.a.	...	...	...

n.a. = not available.

(continued)

TABLE D-IV (continued)

Manufacturing: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1899–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Capital Input	Output Per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				LUMBER AND PRODUCTS, EXCEPT FURNITURE					
1899	90.6	89.2	101.6	107.8	84.0	43.9	206.4	99.5	91.0
1909	115.6	119.5	96.7	139.9	82.6	78.8	146.7	132.0	87.6
1919	87.7	105.6	83.0	117.5	74.6	79.4	110.5	112.5	78.0
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	74.7	79.5	94.0	76.0	98.3	54.8	136.3	72.3	103.3
1948	103.2	87.7	117.7	80.9	127.6	64.4	160.2	78.8	131.0
1953	114.0	79.8	142.9	72.1	158.1	66.9	170.4	72.1	158.1
1957	109.0	68.3	159.6	61.3	177.8	n.a.	...	...	...
				FURNITURE AND FIXTURES					
1899	36.7	44.7	82.1	50.4	72.8	29.6	124.0	48.9	75.1
1909	48.9	65.6	74.5	71.9	68.0	52.7	92.8	70.6	69.3
1919	50.6	74.1	68.3	77.4	65.4	66.1	76.6	76.6	66.1
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	76.6	86.3	88.8	74.9	102.3	62.9	121.8	73.9	103.7
1948	158.4	132.6	119.5	116.2	136.3	64.7	244.8	108.4	146.1
1953	181.3	141.2	128.4	121.1	149.7	73.5	246.7	114.1	158.9
1957	211.8	143.0	148.1	120.6	175.6	n.a.	...	...	...

(continued)

TABLE D-IV (continued)

				PAPER AND ALLIED PRODUCTS					
1899	18.3	37.7	48.5	42.5	43.1	20.5	89.3	37.9	48.3
1909	36.7	59.5	61.7	63.4	57.9	45.7	80.3	59.7	61.5
1919	52.8	88.7	59.5	86.6	61.0	70.6	74.8	83.2	63.5
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	122.0	107.4	113.6	86.1	141.7	90.8	134.4	87.0	140.2
1948	198.2	154.8	128.0	130.2	152.2	122.8	161.4	127.4	155.6
1953	250.1	174.8	143.1	145.4	172.0	156.8	159.5	148.2	168.8
1957	297.4	186.0	159.9	149.8	198.5	n.a.	...	...	...
				PRINTING AND PUBLISHING					
1899	17.1	45.1	37.9	50.4	33.9	40.2	42.5	48.6	35.2
1909	35.5	67.7	52.4	70.8	50.1	60.7	58.5	69.0	51.4
1919	54.0	79.3	68.1	78.0	69.2	77.6	69.6	77.9	69.3
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	101.6	99.0	102.6	82.4	123.3	84.3	120.5	82.7	122.9
1948	146.2	130.8	111.8	112.0	130.5	108.7	134.5	111.5	131.1
1953	168.2	143.1	117.5	120.2	139.9	113.2	148.6	119.1	141.2
1957	195.3	155.4	125.7	127.7	152.9	n.a.	...	...	...
				CHEMICALS AND ALLIED PRODUCTS					
1899	18.6	37.9	49.1	45.3	41.1	25.7	72.4	37.8	49.2
1909	31.4	57.4	54.7	67.4	46.6	47.4	66.2	59.8	52.5
1919	51.5	106.0	48.6	113.5	45.4	92.3	55.8	105.4	48.9
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	123.9	109.0	113.7	97.4	127.2	97.6	126.9	97.5	127.1
1948	309.8	174.7	177.3	160.0	193.6	169.1	183.2	163.5	189.5
1953	470.9	203.3	231.6	181.3	259.7	242.2	194.4	202.9	232.1
1957	612.8	214.8	285.3	190.2	322.2	n.a.	...	...	...

n.a. = not available.

(continued)

TABLE D-IV (continued)

Manufacturing: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1899–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Capital Input	Output Per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				PETROLEUM AND COAL PRODUCTS					
1899	8.7	26.5	32.8	33.2	26.2	12.7	68.5	19.1	45.5
1909	16.1	39.6	40.7	45.3	35.5	27.6	58.3	33.1	48.6
1919	39.1	89.4	43.7	92.4	42.3	87.6	44.6	89.1	43.9
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	113.6	103.1	110.2	73.2	155.2	103.5	109.8	91.6	124.0
1948	201.2	159.8	125.9	127.2	158.2	157.3	127.9	145.7	138.1
1953	254.3	168.3	151.1	127.9	198.8	181.8	139.9	158.8	160.1
1957	278.2	162.4	171.3	120.9	230.1	n.a.	...	...	...
				RUBBER PRODUCTS					
1899	4.3	23.0	18.7	26.2	16.4	8.2	52.4	23.0	18.7
1909	7.7	32.5	23.7	36.6	21.0	16.1	47.8	32.9	23.4
1919	53.7	119.6	44.9	120.1	44.7	78.2	68.7	112.6	47.7
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	90.6	87.2	103.9	68.9	131.5	55.1	164.4	66.1	137.1
1948	170.2	136.5	124.7	118.9	143.1	97.9	173.9	114.8	148.3
1953	212.9	149.9	142.0	132.8	160.3	114.7	185.6	129.7	164.1
1957	223.7	144.5	154.8	131.4	170.2	n.a.	...	...	...

(continued)

TABLE D-IV (continued)

				LEATHER AND PRODUCTS					
1899	64.0	76.2	84.0	94.6	67.7	65.2	98.2	89.9	71.2
1909	82.8	96.6	85.7	116.8	70.9	109.8	75.4	115.7	71.6
1919	90.1	111.6	80.7	115.8	77.8	142.6	63.2	120.1	75.0
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	108.4	101.6	106.7	84.0	129.0	67.5	160.6	81.8	132.5
1948	119.5	106.6	112.1	89.3	133.8	67.7	176.5	86.3	138.5
1953	116.6	101.8	114.5	85.0	137.2	74.7	156.1	84.1	138.6
1957	125.4	98.4	127.4	81.0	154.8	n.a.	...	...	...
				STONE, CLAY, AND GLASS PRODUCTS					
1899	29.9	66.2	45.2	80.6	37.1	29.2	102.4	69.8	42.8
1909	56.3	97.8	57.6	115.3	48.8	69.1	81.5	105.6	53.3
1919	55.9	92.4	60.5	103.4	54.1	75.9	73.6	97.6	57.3
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	99.6	92.7	107.4	87.0	114.5	70.8	140.7	83.3	119.6
1948	177.6	140.9	126.0	134.3	132.2	80.6	220.3	119.4	148.7
1953	214.8	146.7	146.4	137.8	155.9	101.7	211.2	128.4	167.3
1957	242.5	150.1	161.6	138.5	175.1	n.a.	...	...	...
				PRIMARY METAL INDUSTRIES					
1899	21.8	45.1	48.3	53.6	40.7	25.7	84.8	46.1	47.3
1909	43.5	61.4	70.8	73.5	59.2	63.1	68.9	70.7	61.5
1919	62.1	98.9	62.8	108.8	57.1	98.9	62.8	106.1	58.5
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	89.5	113.2	79.1	96.1	93.1	108.5	82.5	99.0	90.4
1948	161.3	150.4	107.2	131.8	122.4	109.9	146.8	126.0	128.0
1953	194.3	163.4	118.9	143.1	135.8	161.6	120.2	147.8	131.5
1957	195.8	160.7	121.8	134.4	145.7	n.a.	...	...	...

n.a. = not available.

(continued)

TABLE D-IV (continued)

Manufacturing: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1899–1957
(1929 = 100)

	Output	Persons Engaged	Output Per Person	Manhours	Output Per Manhour	Capital Input	Output Per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				FABRICATED METAL PRODUCTS					
1899	20.6	45.6	45.2	54.9	37.5	25.8	79.8	48.5	42.5
1909	41.3	73.0	56.6	82.9	49.8	57.6	71.7	77.3	53.4
1919	60.1	94.2	63.8	98.9	60.8	77.8	77.2	94.3	63.7
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	93.7	99.6	94.1	89.8	104.3	76.5	122.5	86.7	108.1
1948	181.4	159.8	113.5	147.2	123.2	117.1	154.9	140.2	129.4
1953	312.8	212.8	147.0	196.8	158.9	164.7	189.9	188.9	165.6
1957	287.8	194.6	147.9	174.1	165.3	n.a.	...	...	...
				MACHINERY, NONELECTRIC					
1899	28.1	44.5	63.1	48.2	58.3	33.2	84.6	44.5	63.1
1909	44.5	62.2	71.5	63.9	69.6	62.9	70.7	63.6	70.0
1919	73.6	103.3	71.2	98.7	74.6	94.3	78.0	97.6	75.4
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	100.6	103.0	97.7	86.2	116.7	77.3	130.1	84.1	119.6
1948	218.9	194.1	112.8	162.5	134.7	156.4	140.0	160.8	136.1
1953	287.6	217.5	132.2	185.3	155.2	192.9	149.1	186.0	154.6
1957	281.6	216.9	129.8	178.8	157.5	n.a.	...	...	...

(continued)

TABLE D-IV (concluded)

ELECTRIC MACHINERY									
1899	7.7	11.1	69.4	12.9	59.7	8.3	92.8	11.9	64.7
1909	18.5	25.3	73.1	27.2	68.0	25.1	73.7	26.8	69.0
1919	46.3	69.3	66.8	68.3	67.8	54.4	85.1	65.4	70.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	93.5	89.6	104.4	74.5	125.5	63.8	146.6	72.7	128.6
1948	251.9	185.2	136.0	156.7	160.8	147.2	171.1	155.2	162.3
1953	458.0	258.1	177.5	218.4	209.7	227.6	201.2	220.6	207.6
1957	511.0	261.5	195.4	218.7	233.7	n.a.	...	...	...
TRANSPORTATION EQUIPMENT									
1899	7.3	33.4	21.9	41.4	17.6	19.3	37.8	35.9	20.3
1909	10.7	44.3	24.2	53.6	20.0	28.3	37.8	47.3	22.6
1919	60.8	144.9	42.0	145.6	41.8	107.8	56.4	136.2	44.6
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	90.7	108.1	83.9	92.2	98.4	97.3	93.2	93.4	97.1
1948	163.7	171.8	95.3	156.2	104.8	139.0	117.8	152.0	107.7
1953	310.8	268.8	115.6	254.8	122.0	198.1	156.9	240.0	129.5
1957	358.2	263.4	136.0	246.1	145.6	n.a.	...	...	...
MISCELLANEOUS AND INSTRUMENTS									
1899	29.3	44.0	66.6	52.4	55.9	25.4	115.4	46.7	62.7
1909	54.7	76.0	72.0	87.7	62.4	53.3	102.6	80.5	68.0
1919	69.5	112.0	62.1	118.5	58.6	72.5	95.9	108.8	63.9
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	106.2	95.0	111.8	89.0	119.3	70.2	151.3	84.6	125.5
1948	226.4	160.0	141.5	151.8	149.1	120.9	187.3	144.5	156.7
1953	302.1	186.0	162.4	173.7	173.9	141.2	214.0	165.9	182.1
1957	349.4	187.0	186.8	169.6	206.0	n.a.	...	...	...

n.a. = not available.

TABLE D-V

Manufacturing: Output and Labor Productivity, by Industry, Key Years, 1899–1954 (1929 = 100)

(These 70 industries represent part of the sample of 80 used for the productivity analyses in Chapters 6 and 7. Seven groups are included in the sample because no representative industry data were obtainable. The 10 remaining industries, for which capital data are available, appear in Table D-VI. O = output; O/E = output per person engaged; O/MH = output per manhour.)

	1899	1909	1919	1937	1947	1954
			DAIRY PRODUCTS (202)			
O	18.5	30.6	64.9	111.3	196.8	179.7
O/E	43.6	48.8	65.4	114.7	139.3	155.0
O/MH	38.5	43.9	59.7	116.5	146.3	176.5
			CANNING, PRESERVING, AND FREEZING: SEAFOOD (2031–32)			
O	52.8	77.8	84.8	103.7	135.5	144.3
O/E	101.5	104.4	90.3	79.6	90.8	129.8
O/MH	83.9	87.6	82.7	97.7	122.1	183.4
			CANNING, PRESERVING, AND FREEZING: FRUITS AND VEGETABLES (2033–35, 2037)			
O	16.9	28.6	54.8	150.8	268.2	402.6
O/E	38.0	54.5	67.4	111.6	163.7	241.5
O/MH	32.3	47.0	62.6	128.6	189.7	288.4
			FLOUR AND MEAL (2041, 2045)			
O	93.7	102.5	113.5	85.8	129.1	109.7
O/E	79.5	64.7	62.4	96.4	130.5	138.0
O/MH	65.0	54.3	56.9	100.5	122.3	140.8
			RICE CLEANING AND POLISHING (2044)			
O	20.6	51.9	88.2	106.2	176.5	233.2
O/E	51.8	62.8	58.3	80.9	94.8	129.6
O/MH	42.0	52.6	51.0	89.5	98.5	140.7
			BAKERY PRODUCTS (205)			
O	22.3[a]	43.9[a]	64.9[a]	97.4	137.7	146.9
O/E	69.5	76.9	81.7	84.8	114.8	117.9
O/MH	55.1	65.1	78.7	91.1	119.5	130.3
			RAW CANE SUGAR (2061)			
O	115.2[b]	167.9	124.7	192.1	190.7	225.0
O/E	64.0	86.9	48.7	108.8	112.3	200.7
O/MH	46.5	67.2	43.8	128.5	127.5	217.6
			CANE-SUGAR REFINING (2062)			
O	44.3[b]	54.8	79.2	89.0	103.4	107.7
O/E	62.4	84.4	60.3	88.6	93.8	105.7
O/MH	47.4	69.8	54.0	103.9	104.0	127.5
			BEET SUGAR (2063)			
O	6.7	45.4	67.4	119.8	163.9	173.5
O/E	26.3	49.9	43.8	98.0	109.6	141.1
O/MH	19.6	40.6	37.9	117.5	129.7	176.5

(continued)

TABLE D-V (continued)

	1899	1909	1919	1937	1947	1954
			CORN PRODUCTS (2094)			
O	43.8[a]	46.8	69.4	84.3	156.0	154.8
O/E	52.5	66.2	65.8	85.2	100.2	90.3
O/MH	37.6	49.0	59.8	92.2	100.0	102.9
			VINEGAR AND CIDER (2096)			
O	101.0[a]	112.5[a]	143.3[a]	85.6[a]	70.4	98.0
O/E	65.5	60.8	71.4	95.9	97.8	113.3
O/MH	56.6	54.3	66.4	109.2	108.8	131.4
			MANUFACTURED ICE (2097)			
O	9.8	29.7	59.8	75.3	105.1	49.2
O/E	44.5	58.0	63.8	118.2	116.0	120.0
O/MH	34.9	46.9	58.0	119.9	118.9	137.9
			BEVERAGES GROUP (208)			
O	295.9	433.6	158.9	684.9	1,325.3	1,365.1
O/E	195.8	197.7	97.1	269.1	334.5	348.1
O/MH	160.3	183.3	94.8	293.8	342.4	396.3
			DISTILLED LIQUORS, EXCEPT BRANDY (2085)			
O	2,573.8[b]	3,365.1[b]	108.3[b]	10,696.3[b]	10,204.2[b]	8,265.4
O/E	949.7	746.8	115.2	1,783.3	1,062.3	1,218.7
O/MH	845.0	691.4	114.7	2,201.8	1,275.2	1,537.2
			CIGARETTES AND CIGARS (2111, 2121)			
O	22.0	32.0	61.0	122.0	200.1	221.5
O/E	22.2	24.2	47.3	162.7	319.1	387.9
O/MH	19.7	22.3	45.4	190.6	361.2	445.7
			CHEWING AND SMOKING TOBACCO (2131)			
O	88.6	129.8	127.5	82.9	82.5	76.3
O/E	34.5	51.3	71.3	87.4	98.2	134.1
O/MH	30.2	45.3	66.7	107.8	113.5	171.8
			WOOLEN AND WORSTED MANUFACTURES (221)			
O	71.3	102.8	97.5	114.4	162.5	99.1
O/E	85.7	95.4	86.7	107.1	143.8	172.3
O/MH	68.1	78.1	84.6	137.7	163.2	199.0
			COTTON GOODS (2223–24, 2233)			
O	49.1	67.5	77.9	98.9	138.0	149.5
O/E	71.0	78.3	77.1	100.1	129.9	165.9
O/MH	61.0	69.3	84.4	130.0	154.2	208.5
			SILK AND RAYON GOODS (2222, 2225, 2234)			
O	22.1	39.6	63.7	135.3	217.4	317.2
O/E	44.8	52.8	65.3	152.9	241.0	389.2
O/MH	40.3	47.7	68.6	203.5	280.9	477.0
			WOOL CARPETS, RUGS, AND CARPET YARN (2271)			
O	60.7	78.3	61.9	92.4	151.6	123.1
O/E	72.3	79.2	89.6	97.9	147.0	159.2
O/MH	60.0	67.6	85.9	123.2	156.3	183.2

(continued)

TABLE D-V (continued)

	1899	1909	1919	1937	1947	1954
			FUR-FELT HATS AND HAT BODIES (2281)			
O	79.3	125.8	94.4	100.0	91.0	45.3
O/E	71.6	85.0	85.0	107.4	130.6	103.7
O/MH	58.7	73.5	86.3	133.9	146.5	123.8
			WOOL-FELT HATS AND HAT BODIES (2282)			
O	135.1	100.8	79.4	256.0	323.4	232.8
O/E	135.1	106.0	107.7	131.9	162.8	295.4
O/MH	122.3	98.7	106.9	180.4	213.7	392.6
			JUTE (EXCEPT FELT) AND LINEN GOODS (2297)			
O	75.5	125.7	109.7	123.9	103.3	103.4
O/E	73.2	91.5	87.9	106.3	143.3	153.6
O/MH	59.4	77.4	84.7	131.0	150.6	178.9
			CORDAGE AND TWINE (2298)			
O	66.8	82.3	92.8	92.1	99.3	91.2
O/E	77.0	84.2	76.8	96.0	104.0	126.7
O/MH	66.3	75.6	74.1	124.6	121.5	154.6
			APPAREL GROUP (23)			
O	30.4[a]	50.8[a]	64.2[a]	103.9	147.9	165.6
O/E	56.5	58.3	67.6	95.2	100.5	108.3
O/MH	44.5	48.7	67.7	118.2	111.6	126.0
			FURNITURE GROUP (25)			
O	36.7[a]	48.9[a]	50.6[a]	76.6[a]	152.6[a]	189.2
O/E	82.1	74.5	68.3	88.8	114.7	144.2
O/MH	72.8	68.0	65.4	102.3	129.2	171.2
			PULP, PAPER, AND PAPER BOARD			
O	19.4	36.5	52.7	119.8	197.9	263.2
O/E	52.9	64.4	60.6	112.0	117.4	142.9
O/MH	47.4	61.0	59.4	143.6	138.5	175.5
			CONVERTED PAPER PRODUCTS (2641–2699)			
O	17.8[a]	35.9[a]	54.1[a]	134.4[a]	205.9	273.8
O/E	45.8	57.4	59.7	124.7	145.7	158.2
O/MH	40.0	53.1	64.3	150.5	172.3	192.7
			PRINTING AND PUBLISHING GROUP (27)			
O	17.1	35.5	54.0	101.6	139.1	175.3
O/E	37.9	52.4	68.1	102.6	108.7	120.6
O/MH	33.9	50.1	69.2	123.3	124.3	145.2
			CHEMICALS, N.E.C., RAYON, AND GASES			
O	6.6	12.5	36.3	171.6	495.9	952.6
O/E	41.8	52.3	48.5	130.4	214.6	301.1
O/MH	33.7	43.0	45.6	143.2	240.3	344.4
			EXPLOSIVES (2826)			
O	25.3	61.6	93.6	92.8	147.7	310.0
O/E	38.4	73.2	50.9	96.6	122.3	82.4
O/MH	29.2	56.7	46.7	99.8	124.1	83.9

(continued)

TABLE D-V (continued)

	1899	1909	1919	1937	1947	1954
			SOAP AND GLYCERINE (2841)			
O	38.0[a]	61.4	89.4	109.0	176.0	192.4
O/E	66.2	67.5	62.6	117.8	130.4	151.6
O/MH	56.4	58.4	61.1	129.0	132.5	175.5
			PAINTS AND ALLIED PRODUCTS (285)			
O	22.2	37.5	52.2	109.0	195.1	208.8
O/E	70.5	74.6	66.8	105.1	135.7	143.0
O/MH	67.7	72.7	71.5	131.5	166.0	186.3
			HARDWOOD AND SOFTWOOD DISTILLATION (2861–62)			
O	28.2	54.1	74.6	101.3	144.0	178.3
O/E	80.3	90.6	68.6	104.8	116.3	153.2
O/MH	66.5	76.5	62.0	118.9	139.9	180.6
			GUM NAVAL STORES (2863)			
O	119.3	90.5	75.6	80.6	39.6	28.4
O/E	110.0	88.2	105.4	97.1	138.5	124.6
O/MH	90.1	74.7	92.8	99.3	141.4	134.6
			NATURAL TANNING AND DYEING MATERIALS, SULFONATED OILS, AND ASSISTANTS (2865, 2843)			
O	25.9	53.7	81.7	101.4	128.9	151.5
O/E	42.7	56.4	49.7	87.0	101.2	131.4
O/MH	37.1	49.9	44.1	98.5	115.5	168.7
			COTTONSEED OIL MILLS (2881)			
O	50.7	73.3	111.0	82.8	77.4	130.0
O/E	72.8	66.0	66.1	81.1	93.4	165.4
O/MH	57.4	53.9	56.5	74.9	93.1	172.4
			LINSEED OIL MILLS (2882)			
O	42.6[a]	42.5[a]	50.5[a]	86.0	59.9	78.8
O/E	87.3	74.2	56.2	88.7	112.2	184.1
O/MH	61.0	51.4	44.5	83.5	117.2	167.7
			GREASE AND TALLOW (2886)			
O	32.8[a]	49.0[a]	62.8[a]	90.9[a]	225.6[a]	333.9
O/E	89.6	60.3	51.4	96.5	120.7	194.4
O/MH	73.2	50.2	46.0	101.6	115.3	188.5
			GLUE AND GELATIN (2894)			
O	28.3[a]	66.8[a]	92.6[a]	138.7	168.0	155.9
O/E	54.7	61.9	67.2	117.9	116.3	125.9
O/MH	45.7	52.6	62.6	127.5	117.8	146.4
			CARBON BLACK (2895)			
O	3.4[a]	8.2[a]	22.9	133.2	316.2	335.4
O/E	68.0	59.4	60.9	118.9	213.4	211.3
O/MH	60.7	54.3	55.9	137.7	253.2	246.1
			SALT (2898)			
O	53.3	67.4	88.2	96.9	112.4	112.6
O/E	62.9	75.3	71.6	118.0	128.8	154.0
O/MH	53.3	65.1	66.0	133.3	144.1	167.6

(continued)

TABLE D-V (continued)

	1899	1909	1919	1937	1947	1954
			COKE OVEN PRODUCTS (293)			
O	18.2	38.3	61.4	87.3	137.1	126.1
O/E	24.1	29.7	45.2	90.4	87.7	81.5
O/MH	18.9	25.6	39.2	123.1	102.2	118.2
			RUBBER PRODUCTS GROUP (30)			
O	4.3[a]	7.7[a]	53.7	90.6	176.4	201.1
O/E	18.7	23.7	44.9	103.9	121.2	147.9
O/MH	16.4	21.0	44.7	131.5	136.4	171.7
			INDUSTRIAL LEATHER BELTING (3121)			
O	47.3[a]	76.3[a]	78.6[a]	86.5	121.4[a]	128.7[a]
O/E	76.4	63.0	70.5	85.6	94.5	111.0
O/MH	66.1	55.8	66.3	100.3	101.7	126.4
			LEATHER GLOVES AND MITTENS (315)			
O	76.0	87.9	94.1	98.0	94.2	66.9
O/E	59.2	82.9	91.4	79.5	82.6	98.5
O/MH	50.6	74.3	89.4	96.5	107.5	132.2
			SADDLERY, HARNESS, AND WHIPS (3192)			
O	539.4[a]	664.8[a]	302.1[a]	59.3[a]	57.2[a]	25.3
O/E	131.4	146.8	88.6	72.7	92.3	87.2
O/MH	106.9	126.7	80.5	79.8	99.1	98.4
			GLASS (3211, 3221, 3229)			
O	24.9	45.0	64.3	162.6	256.9	297.0
O/E	33.3	46.0	57.0	137.2	164.3	189.2
O/MH	29.7	40.4	55.3	160.0	179.5	211.5
			CEMENT, LIME, CONCRETE (324, 327)			
O	9.9	47.8	53.1	82.0	182.9	286.2
O/E	34.5	58.2	68.3	94.6	104.8	138.1
O/MH	28.2	49.5	61.2	114.2	113.8	154.9
			STRUCTURAL CLAY AND POTTERY PRODUCTS (325, 326, 3297)			
O	55.8	79.4	64.0	72.9	108.3	111.9
O/E	67.4	77.0	77.3	96.4	112.7	121.1
O/MH	57.1	68.4	71.6	107.5	127.9	132.6
			BLAST FURNACES (3311, 3313)			
O	32.4	58.1	69.8	87.8	126.9	125.6
O/E	22.3	38.7	41.1	96.4	87.7	84.5
O/MH	15.5	28.1	33.2	107.1	103.8	105.2
			STEEL MILL PRODUCTS (3312, 3323, 3393, 3399)			
O	23.5	43.3	63.2	97.0	152.3	155.3
O/E	52.8	73.1	66.0	80.5	118.4	123.8
O/MH	46.4	60.8	59.5	95.6	138.2	152.9
			PRIMARY NONFERROUS METALS (333)			
O	24.9	48.8	64.2	77.9	115.4	200.8
O/E	33.8	53.9	54.2	81.2	104.3	143.6
O/MH	30.4	48.1	51.2	93.5	121.0	177.9

(continued)

TABLE D-V (continued)

	1899	1909	1919	1937	1947	1954
NONFERROUS METALS, N.E.C. (3351, 3359, 3361)						
O	13.9[a]	28.3[a]	56.6[a]	88.5	187.1	206.4
O/E	39.6	54.2	57.8	85.4	112.1	118.6
O/MH	36.3	49.3	56.2	99.9	130.4	138.5
CUTLERY AND EDGE TOOLS (3421–22)						
O	42.6[a]	56.9[a]	84.0[a]	80.2[a]	140.3[a]	133.1
O/E	56.1	52.3	63.6	72.3	84.6	104.0
O/MH	46.0	45.4	58.7	77.3	89.5	116.2
HAND TOOLS, N.E.C., FILES, HAND SAWS (3423–25)						
O	29.5[a]	51.7[a]	97.0[a]	83.4[a]	214.7[a]	141.9
O/E	84.3	81.0	76.5	91.0	144.6	138.8
O/MH	70.1	71.4	70.5	98.2	153.0	158.2
OIL BURNERS AND HEATING AND COOKING APPARATUS, N.E.C. (3432, 3439)						
O	15.3[a]	39.1[a]	68.2[a]	93.0[a]	192.6	152.9
O/E	40.2	56.6	72.0	90.4	124.4	153.2
O/MH	33.6	47.9	68.1	98.1	132.4	171.2
STRUCTURAL AND ORNAMENTAL PRODUCTS (3441)						
O	18.0[a]	39.7[a]	46.7[a]	54.5[a]	91.4	138.0
O/E	43.4	58.3	58.4	78.8	84.4	86.5
O/MH	37.0	52.7	56.7	87.8	93.0	98.6
SHEET-METAL WORK (3444)						
O	21.3[a]	59.7[a]	54.9[a]	71.2[a]	136.6[a]	178.0[a]
O/E	42.1	63.9	55.6	92.8	124.7	137.0
O/MH	35.4	57.0	54.4	99.2	128.4	146.4
NAILS AND SPIKES (3481)						
O	127.1[a]	87.6[a]	103.1[a]	87.6[a]	144.2[a]	126.0
O/E	60.8	65.3	63.2	74.8	94.9	103.6
O/MH	49.3	56.1	61.2	88.4	102.9	111.0
WIREWORK, N.E.C. (3489)						
O	16.6[a]	47.1[a]	50.0[a]	102.3[a]	202.9	227.5
O/E	39.9	82.5	71.5	69.5	94.2	100.2
O/MH	33.2	72.7	67.6	77.1	105.3	115.0
BOLTS, NUTS, WASHERS, RIVETS, AND SCREW-MACHINE PRODUCTS (3494-95)						
O	10.5[a]	23.6[a]	44.6[a]	85.9[a]	200.7[a]	214.1
O/E	35.0	53.3	49.0	80.7	106.6	99.8
O/MH	29.5	47.5	47.7	100.9	131.3	126.2
FOUNDRY AND MACHINE SHOP PRODUCTS SUBGROUP (group 35 less farm and office machinery)						
O	26.3[a]	41.1[a]	72.5[a]	102.3[a]	218.8[a]	253.2
O/E	61.7	69.7	71.3	99.1	111.9	128.5
O/MH	57.4	68.4	75.3	118.3	133.5	156.7
ELECTRIC MACHINERY (36)						
O	7.7[a]	18.5[a]	46.3[a]	93.5[a]	251.1	414.3
O/E	69.4	73.1	66.8	104.4	129.8	179.4
O/MH	59.7	68.0	67.8	125.5	152.6	215.7

(continued)

TABLE D-V (concluded)

	1899	1909	1919	1937	1947	1954
			MOTOR VEHICLES AND EQUIPMENT (371)			
O	0.05	1.8	28.2	90.1	115.3	143.0
O/E	10.0	10.5	35.4	84.0	86.2	106.6
O/MH	7.8	8.3	33.0	98.9	94.6	112.5
			LOCOMOTIVES AND PARTS (3741)			
O	263.9	282.5	321.2	55.2	134.9	130.9
O/E	170.7	214.2	143.6	64.6	62.7	88.6
O/MH	142.6	187.8	136.6	69.6	74.4	106.8
			RAILROAD AND STREET CARS (3742)			
O	119.4	113.7	170.7	93.4	145.3	62.5
O/E	143.9	106.0	130.9	95.8	80.7	68.9
O/MH	119.3	92.1	124.0	110.1	88.4	80.6
			TRANSPORTATION EQUIPMENT, N.E.C. (3799)			
O	1,316.6	1,333.2	647.2	71.3	168.6	64.3
O/E	71.1	77.6	117.1	108.0	118.4	125.3
O/MH	61.0	67.1	105.1	126.9	129.4	145.5
			INSTRUMENTS AND MISCELLANEOUS MANUFACTURES (38, 39)			
O	29.3[a]	54.7[a]	69.5[a]	106.2[a]	213.2[a]	293.4
O/E	66.6	72.0	62.1	111.8	130.0	164.8
O/MH	55.9	62.4	58.6	119.3	137.0	179.8
			PIANOS (3931)			
O	69.2	156.1	188.7	66.0	67.8	71.9
O/E	51.6	61.2	81.7	117.0	109.4	140.4
O/MH	38.7	53.0	77.3	122.4	110.4	158.0

[a] Output is measured by deflated value (see Technical Note to Appendix D for price series used as deflators).

[b] Quantity data used for output index is from a source other than *Census of Manufactures*. For the sugar industries the source is the Department of Agriculture; for the liquor industry the source is the Internal Revenue Service.

TABLE D-VI

Manufacturing: Output and Productivity Ratios, by Industry, Key Years, 1899–1954 (1929 = 100)

(Index numbers for 36 industries for which capital data are available are here summarized. Data for 1947 and 1954 are presented for those 10 industries which are included in the sample of 80 used for analysis in Chapters 6 and 7. Capital data for 8 industries are unavailable for 1929 and 1937, and for 3 industries, unavailable for 1899 through 1919. O = output; O/E = output per person engaged; O/MH = output per manhour; O/C = output per unit of capital input; O/I = total factor productivity.)

	1899	1909	1919	1937	(1947)	1948	(1954)
MEAT PACKING AND PREPARED MEATS (2011, 2013)							
O	54.1	69.6	90.4	98.0	144.6	134.8	159.3
O/E	106.1	102.8	72.0	91.3	96.7	91.6	101.7
O/MH	95.6	92.9	75.2	114.8	110.6	107.0	123.1
O/C	112.7	88.0	53.2	117.8		104.0	
O/I	97.7	92.2	71.0	115.2		106.6	
CANNING, PRESERVING, AND FREEZING (203)							
O	19.8	32.7	57.3	145.9		257.2	
O/E	43.6	59.5	69.2	108.5		158.1	
O/MH	37.0	51.2	64.2	124.7		189.1	
O/C	104.2	102.5	81.2	146.5		151.6	
O/I	44.0	58.4	67.7	129.5		178.2	
GRAIN MILL PRODUCTS EXCEPT CEREALS (2041, 2042, 2044, 2045)							
O	74.7	81.8	90.5	93.7		166.2	
O/E	79.6	64.9	62.6	91.1		103.2	
O/MH	65.4	54.7	57.2	96.4		105.8	
O/C	65.2	47.9	35.3	82.9		104.5	
O/I	65.3	52.6	48.7	92.1		105.4	
BAKERY PRODUCTS AND CONFECTIONERY AND RELATED PRODUCTS (205, 207)							
O	22.0[a]	44.4[a]	73.6[a]	100.1		144.6	
O/E	64.7	73.8	80.2	93.4		122.5	
O/MH	52.3	62.9	76.5	101.2		129.9	
O/C	128.7	120.3	108.9	136.9		181.0	
O/I	58.2	68.4	80.6	105.9		136.4	
SUGAR INDUSTRIES (206)							
O	29.7	57.3	76.7	103.7		111.9	
O/E	43.9	66.6	50.8	90.0		95.6	
O/MH	33.7	54.3	44.7	106.2		110.7	
O/C	57.2	96.8	112.8	179.7		197.7	
O/I	37.0	60.0	51.5	116.6		122.4	
KNITTING MILLS (225)							
O	19.1	33.1	55.4	115.7	176.0	188.8	207.7
O/E	48.7	54.5	66.6	105.4	176.0	182.6	215.2
O/MH	43.8	49.9	68.0	140.1	221.1	231.7	284.1
O/C	78.0	77.7	67.9	192.8		228.3	
O/I	46.9	52.8	68.0	146.1		231.1	

(continued)

TABLE D-VI (continued)

	1899	1909	1919	1937	(1947)	1948	(1954)
			CARPETS AND RUGS (227)				
O	50.6	68.6	61.9	94.9		208.1	
O/E	68.6	76.7	86.3	103.2		170.2	
O/MH	58.0	66.7	82.8	132.0		181.0	
O/C	143.3	121.4	96.4	123.2		178.2	
O/I	72.7	78.8	86.9	128.9		180.0	
			LUMBER MILL PRODUCTS (242, 243)				
O	100.5	102.0	91.2	70.4	91.0	95.8	114.3
O/E	110.3	81.5	83.7	93.5	102.8	110.6	141.8
O/MH	91.4	69.6	75.1	98.5	110.3	120.1	164.7
O/C	266.6	156.9	145.9	133.8		184.9	
O/I	99.9	75.1	80.2	102.0		125.7	
			INDUSTRIAL CHEMICALS (281, 282)				
O	9.1	17.5	42.0	160.5		502.8	
O/E	40.8	55.7	49.9	126.3		216.4	
O/MH	33.2	46.2	46.9	139.0		241.0	
O/C	44.2	48.5	55.4	130.3		200.2	
O/I	35.8	46.8	49.1	136.2		227.1	
			ALLIED CHEMICAL SUBSTANCES (283–86, 288–89)				
O	29.3	42.9	59.0	98.5		171.6	
O/E	62.2	59.7	53.2	101.8		114.0	
O/MH	52.3	51.1	49.5	114.3		120.8	
O/C	115.4	91.9	83.3	115.7		93.5	
O/I	69.4	63.8	60.6	114.9		106.8	
			FERTILIZERS (287)				
O	30.4	59.9	80.4	105.9	209.0	215.4	320.8
O/E	60.0	70.7	64.1	108.8	174.7	184.1	270.0
O/MH	53.1	63.9	61.2	132.2	202.7	218.5	311.2
O/C	82.8	89.3	73.6	145.1		202.6	
O/I	58.6	68.9	64.0	135.2		214.1	
			PETROLEUM REFINING (2911)				
O	5.9	11.0	34.0	119.2	191.2	209.3	269.6
O/E	43.4	65.9	46.1	114.3	125.6	132.3	169.0
O/MH	35.1	58.5	46.9	163.7	160.3	168.4	227.3
O/C	54.1	60.1	41.7	113.7		135.8	
O/I	46.5	59.5	43.1	125.6		144.4	
			RUBBER TIRES AND INNER TUBES (3011)				
O			50.9[a]	81.3		136.6	
O/E			41.3	105.4		131.5	
O/MH			40.2	143.9		154.9	
O/C			67.4	166.6		170.3	
O/I			44.2	148.4		158.1	
			RUBBER PRODUCTS OTHER THAN TIRES AND TUBES (302, 303, 309)				
O			71.7	106.7		224.3	
O/E			58.8	106.7		121.4	
O/MH			60.1	126.4		137.8	
O/C			83.5	131.2		120.4	
O/I			62.1	127.0		135.4	

(continued)

TABLE D-VI (continued)

	1899	1909	1919	1937	(1947)	1948	(1954)
			LEATHER TANNING AND FINISHING (3111)				
O	69.5	89.3	104.4	112.1	137.8	125.3	112.5
O/E	67.7	72.7	71.9	111.7	142.5	133.2	142.4
O/MH	60.6	66.8	71.3	136.0	166.2	160.0	176.3
O/C	69.9	53.8	59.4	160.1		183.7	
O/I	62.3	63.7	68.6	140.3		164.2	
			FOOTWEAR EXCEPT RUBBER (314)				
O	60.1	78.5	89.2	112.3	128.9	122.7	117.4
O/E	90.1	88.7	85.4	110.0	123.2	116.1	117.2
O/MH	70.2	70.6	82.4	136.1	142.1	140.2	144.2
O/C	143.8	112.3	80.1	156.8		177.3	
O/I	75.5	74.4	82.1	138.6		144.4	
			LEATHER GROUP EXCEPT FOOTWEAR (31 LESS 314)				
O	64.3	85.2	85.9	97.2		107.0	
O/E	69.6	77.0	69.2	96.5		96.4	
O/MH	59.1	67.6	66.5	112.2		112.8	
O/C	81.4	64.5	60.5	149.8		150.5	
O/I	62.4	67.0	65.3	117.8		118.4	
			PRIMARY IRON AND STEEL				
O	23.0	44.4	64.2	93.8		167.5	
O/E	48.8	69.6	64.4	80.9		112.4	
O/MH	40.5	57.3	57.8	95.3		128.5	
O/C	81.3	59.2	55.4	77.1		129.0	
O/I	46.0	57.7	57.2	90.2		128.5	
			PRIMARY NONFERROUS METALS				
O	16.0	32.4	56.5	81.1		171.5	
O/E	42.0	61.1	58.7	77.8		108.8	
O/MH	37.6	54.3	55.8	89.6		124.8	
O/C	82.9	84.6	91.9	90.8		109.2	
O/I	44.3	60.3	62.7	89.9		120.0	
			FABRICATED IRON AND STEEL				
O	20.4	38.8	58.2	91.7		164.8	
O/E	48.1	57.1	62.5	93.7		108.3	
O/MH	39.9	50.3	59.2	104.2		118.1	
O/C	86.4	73.1	75.8	122.8		141.0	
O/I	45.0	53.8	62.0	107.6		122.3	
			FABRICATED NONFERROUS METALS				
O	21.3	46.2	64.5	98.2		197.7	
O/E	41.0	55.2	66.7	95.2		111.8	
O/MH	33.6	48.1	64.0	105.4		120.4	
O/C	61.0	67.8	74.2	117.5		112.6	
O/I	37.9	51.9	66.3	108.1		118.4	
			HEATING AND PLUMBING EQUIPMENT AND STRUCTURAL METAL PRODUCTS (343, 344)				
O	14.2	36.3	51.2	81.0		165.8	
O/E	40.2	55.0	64.3	90.8		142.8	
O/MH	33.3	48.3	61.9	99.5		153.7	
O/C	65.7	63.1	71.4	111.1		136.7	
O/I	37.4	50.9	63.8	101.9		149.6	

(continued)

TABLE D-VI (continued)

	1899	1909	1919	1937	(1947)	1948	(1954)
			FARM MACHINERY EXCEPT TRACTORS (3522)				
O	72.2[a]	99.1[a]	99.9[a]	76.7[a]	175.7	222.7	164.6
O/E	64.3	79.4	71.8	87.1	114.9	139.9	135.9
O/MH	57.8	73.7	70.8	108.0	140.3	171.7	175.1
O/C	86.0	72.1	83.9	136.2		164.1	
O/I	65.5	73.1	75.0	116.7		168.8	
			OFFICE AND STORE MACHINES (357)				
O	15.6	46.1	67.6	97.2	172.7	181.1	245.4
O/E	64.7	82.5	70.7	84.2	96.9	100.8	133.1
O/MH	55.3	74.6	66.9	92.9	103.4	109.1	151.0
O/C	87.2	88.3	85.6	115.2		86.2	
O/I	64.7	79.5	73.2	100.7		98.6	
			MOTOR VEHICLES, MOTORCYCLES, AND BICYCLES (371, 3751)				
O	0.3	2.0	28.9	90.5		123.8	
O/E	6.0	11.2	35.5	84.1		90.2	
O/MH	4.7	8.9	33.1	98.9		100.5	
O/C	12.5	23.0	45.7	96.6		92.0	
O/I	5.7	10.7	35.9	98.3		98.0	
			AIRCRAFT AND PARTS (372)				
O			19.1[a]	162.6[a]		1,100.7[a]	
O/E			84.9	95.5		118.0	
O/MH			81.6	96.0		122.3	
O/C			72.3	76.5		89.3	
O/I			79.9	92.2		115.5	
			SHIPS AND BOATS (373)				
O	97.0	73.9	551.2	80.5	185.6	165.9	212.0
O/E	119.3	101.2	82.1	70.4	76.5	77.5	103.3
O/MH	99.0	87.5	91.2	82.4	83.3	86.3	117.3
O/C	176.7	114.2	111.1	95.0		80.3	
O/I	106.5	90.9	93.9	84.2		85.3	
			RAILROAD EQUIPMENT (374)				
O	149.2	147.0	202.5	82.3		165.3	
O/E	151.9	130.7	134.9	86.7		83.9	
O/MH	126.0	113.6	127.0	98.4		94.8	
O/C	346.2	309.5	226.0	79.7		80.4	
O/I	137.4	123.7	134.7	95.5		92.6	

(continued)

TABLE D-VI (concluded)

	1948 = 100			*1948 = 100*		
	1899	1909	1919	1899	1909	1919
	PULP, PAPER, AND PAPERBOARD (261)			CEMENT, LIME, AND CONCRETE (324, 327)		
O	9.3	17.6	25.3	4.7	22.6	25.1
O/E	44.3	54.3	50.9	30.1	50.7	59.5
O/MH	33.6	43.5	42.1	22.6	39.4	48.8
O/C	55.7	45.7	45.7	28.1	28.9	34.6
O/I	38.6	44.2	43.2	23.7	36.3	44.5
	CONVERTED PAPER PRODUCTS (264–269)			STRUCTURAL CLAY AND POTTERY PRODUCTS (325, 326, 3297)		
O	8.5	17.1	25.7	47.6	67.7	54.6
O/E	30.7	38.4	39.9	58.5	66.9	67.2
O/MH	22.5	29.8	35.9	43.5	52.2	54.7
O/C	72.0	66.5	60.5	56.6	40.2	38.3
O/I	29.0	36.3	41.5	46.0	48.8	49.6
	SOAP AND GLYCERINE, CLEANING AND POLISHING PREPARATIONS (2841–42)			GLASS PRODUCTS (3211, 3221, 3229, 3231)		
O	20.0	32.8	52.5	9.8	18.0	23.7
O/E	57.3	58.8	58.1	20.1	27.2	32.8
O/MH	47.2	49.2	54.6	16.3	21.6	28.8
O/C	90.1	83.7	70.9	36.3	33.0	39.6
O/I	58.7	59.2	60.3	18.7	23.6	30.8
	PAINTS AND ALLIED PRODUCTS (285)			BLAST FURNACES AND STEEL MILLS (331, 3323, 3393, 3399)		
O	11.5	19.4	27.0	15.7	28.7	40.6
O/E	53.7	56.9	50.8	43.1	61.7	56.4
O/MH	42.0	45.2	44.3	29.4	43.6	43.6
O/C	55.3	63.4	60.3	68.0	48.5	44.8
O/I	46.6	51.2	49.7	34.3	44.7	43.8

[a] Output is measured by deflated value (see Technical Note to Appendix D for price series used as deflators).

TABLE D-VII

Manufacturing: Persons Engaged and Manhours, by Group, 1929

Census Code No.		Persons Engaged (thousands)	Manhours (millions)
20	Foods, except beverages	931	2,180
208	Beverages	47	105
21	Tobacco products	138	305
22	Textile mill products	1,296	3,072
23	Apparel and related products	758	1,541
24	Lumber and products except furniture	797	1,809
25	Furniture and fixtures	243	575
26	Paper and allied products	301	773
27	Printing and publishing	627	1,453
28	Chemicals and allied products	378	864
29	Petroleum and coal products	134	346
30	Rubber products	186	420
31	Leather and products	382	856
32	Stone, clay, and glass products	426	922
33	Primary metal industries	754	1,743
34	Fabricated metal products	714	1,589
35	Machinery, nonelectric	1,002	2,487
36	Electric machinery	456	1,089
37	Transportation equipment	704	1,523
38–39	Miscellaneous and instruments	296	638
	Total	10,570	24,290