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Chapter 3

# Changes in Total Manufacturing Output

## CHANGES IN PHYSICAL OUTPUT, 1899–1937

According to the indexes presented in Table 1 and in Chart 1, the flow of output from the manufacturing plants of the United States increased 276 percent from 1899 to 1937. Expressed in terms of the change over yearly intervals, the rate of increase during the entire 38-year period, averaged over good years and bad, was 3.5 percent per annum.

Although these indexes show that manufacturing output was nearly four times as great in 1937 as it had been in 1899, they nevertheless understate the actual development of the product of manufacture because, as we have already noted, they do not encompass changes in the quality of the goods produced. Such information as is available concerning changes in quality indicates that improvements have been dominant. If the betterments in quality could be taken into account, the stream of manufactured goods would show a greater rate of increase than is indicated by the indexes presented here. It is probable, furthermore, that manufacturers have tended to require less materials, fuel and other purchased goods per unit of final product. Some manufacturing industries, indeed, have effected sensational reductions in wastage. If the index took account also of the enhanced efficiency in the use of materials, that is, if it were a precise index of the net physical output of manufacturing industries, as defined in Chapter 2, it would show a still greater rise in the contribution of manufacturing industries to the national product.

The average annual rise of 3.5 percent in total manufactur-

ing output between 1899 and 1937 is a summary measure. Like all such measurements, it conceals highly significant variations. During the entire span of 38 years the course of manufacturing production was subject to striking changes of direction. According to the annual record in Table 1, there were actually nine intervals when manufacturing output declined absolutely. Only two of these declines appear to have exceeded

TABLE 1

ALL MANUFACTURING INDUSTRIES COMBINED

Indexes of Physical Output [a]

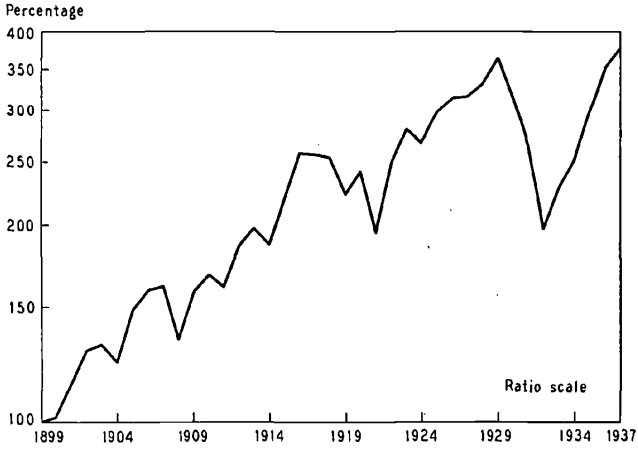
*(1899:100)*

| *Year* | *Index* | *Year* | *Index* |
|---|---|---|---|
| 1899 | 100 | 1919 | 222 |
| 1900 | 102 | 1920 | 242 |
| 1901 | 115 | 1921 | 194 |
| 1902 | 129 | 1922 | 249 |
| 1903 | 132 | 1923 | 280 |
| 1904 | 124 | 1924 | 266 |
| 1905 | 148 | 1925 | 298 |
| 1906 | 159 | 1926 | 316 |
| 1907 | 161 | 1927 | 317 |
| 1908 | 133 | 1928 | 332 |
| 1909 | 158 | 1929 | 364 |
| 1910 | 168 | 1930 | 311 |
| 1911 | 161 | 1931 | 262 |
| 1912 | 185 | 1932 | 197 |
| 1913 | 198 | 1933 | 228 |
| 1914 | 186 | 1934 | 252 |
| 1915 | 218 | 1935 | 301 |
| 1916 | 259 | 1936 | 353 |
| 1917 | 257 | 1937 | 376 |
| 1918 | 254 | | |

[a] The indexes for Census years have been constructed from basic data in the U.S. Census of Manufactures and other sources, by methods described briefly in Chapter 2 and in detail in Appendix A. Appendix B presents these data, together with the indexes derived from them. The indexes have been adjusted to take account of changes in the coverage of the sample. Interpolations for intercensal years are based on annual indexes, less comprehensive in coverage, computed by F. C. Mills, *op. cit.*, p. 563; W. M. Persons, *Forecasting Business Cycles* (John Wiley, 1931), p. 171; W. W. Stewart, *American Economic Review* (March 1921); and the Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin* (August 1940).

one calendar year in duration: the relatively mild drop between 1916 and 1919, and the severe recession beginning in 1929.[1] Some of the shorter declines were nevertheless sharp. The drop of 1907–08 brought output down almost to the level

Chart 1
ALL MANUFACTURING INDUSTRIES COMBINED
Indexes of Physical Output
(1899 : 100)




of 1903, and the slump of 1920–21 caused output to fall below that of 1913. Even in comparison with these sharp declines, the 1929–32 recession was extraordinarily severe. It depressed manufacturing output to a point as low as that reached in 1913 and 1921.[2]

The output of the peak year 1907 was barely surpassed in

[1] This conclusion is based on the annual data. Monthly series would probably show different results, as would also annual data representing fiscal rather than calendar years.

[2] The interpolated index is only roughly accurate for intercensal years, particularly with respect to cyclical movements. It is probable that the cyclical fluctuations revealed by the index are greater than would be shown by an index based on a broader sample than is now available for intercensal years. See the comparison, below, of the index constructed by the National Bureau with the old Federal Reserve index.

the following peak year, 1910, and was not exceeded substantially until 1912. The high point immediately following the 1916 peak came in 1920, but was nevertheless lower than that of 1916, a point which was not actually surpassed until 1923. In these two periods, therefore, the slump in the rate of growth of manufactures extended beyond the period of a business cycle. A similar prolongation of depression appears to have occurred in the most recent decade as well. According to available monthly indexes, manufacturing output in 1938 and 1939 was below that of 1937, a year which stands out as the peak following 1929, though output in 1937 was only slightly greater than it had been in 1929. There were, then, three fairly long periods in the present century when the rate of growth in manufacturing output suffered retardation. The retardation in the two earlier periods proved to be temporary, and the failure of output to advance appreciably from 1929 to 1937 may likewise reflect merely a temporary decline rather than an exhaustion of capacity to expand.

## COMPARISON WITH OTHER INDEXES OF MANUFACTURING OUTPUT

The changes in manufacturing output outlined by the index presented in this volume differ from those revealed by other indexes. Our index records a more rapid long-term growth than do other indexes, and, contrary to most opinion on production trends, an increase between 1929 and 1937. Such divergences require some explanation.

We begin with an examination of the Day-Thomas index,[3] which, like the National Bureau index presented here, is based primarily on Census data; and follow with the index published monthly by the Board of Governors of the Federal Reserve System.[4] The Day-Thomas index and the index com-

[3] The product of extensive collaboration by W. M. Persons, E. E. Day, Woodlief Thomas and other statisticians. (See footnote a, Table 2.)

[4] Another important index is that computed by the National Research

puted for this study are compared in Table 2 and Chart 2; both have been placed on a common base, 1899. In addition the table and chart show the monthly Federal Reserve indexes, reduced to annual averages and based on the first year for which they are available, 1919, as well as our index for 1919–37, also based on 1919 as 100.

The National Bureau index reveals a distinctly more rapid rate of growth than does the Day-Thomas index. The latter rises 203 percent between 1899 and 1937, whereas our index increases by 276 percent. For 1937 our index is 25 percent higher, in relation to the 1899 base, than the Day-Thomas index. The two indexes run parallel to each other between 1899 and 1909, but then begin to diverge. From 1909 to 1937 our index rises by 140 percent, the Day-Thomas by only 90 percent. The latter appears to be more sensitive to most of the cyclical movements than the National Bureau index: it climbs less rapidly between 1909 and 1914, and more rapidly between 1914 and 1919; it falls and rises more precipitately between 1919 and 1923; between 1925 and 1927 it declines slightly, whereas our index moves upward; and between 1929 and 1933 it declines more sharply than our index. Between 1927 and 1929 and between 1933 and 1937, the Day-Thomas index rises less rapidly than the National Bureau index.

The dissimilarities between our index and the Day-Thomas index originate in many differences of construction and cov-

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Project of the Work Projects Administration—see H. Magdoff, I. H. Siegel and M. B. Davis, *Production, Employment and Productivity in 59 Manufacturing Industries, 1919–36,* (Report No. S–1, 3 Parts, 1939). The NRP study was directed toward an analysis of changes in employment. Accordingly, the NRP index of "production" is a measure in which the weights used are man-hours of wage labor expended, rather than value of products or value added. Such weights are appropriate to the special purpose for which the index was designed, but the index so constructed is not an index of production in the ordinary sense. For this reason we do not compare our index of total manufacturing output with the NRP index for 59 industries. However, since most of the NRP indexes for individual industries are weighted in the usual manner, we have checked our indexes for individual industries against them. Outstanding differences are noted below in Appendix D.

erage. A complete explanation of these discrepancies would require a detailed comparison of each of the component series, of the weights used, and of the methods of combination. Com-

TABLE 2

ALL MANUFACTURING INDUSTRIES COMBINED

Comparison of NBER Index of Physical Output with Indexes Prepared by Other Agencies

| Year | Day-Thomas Index[a] | NBER Index[b] | Federal Reserve Index[c] | | NBER Index[b] |
|---|---|---|---|---|---|
| | | | Old | New | |
| | (1899:100) | | (1919:100)[c] | | |
| 1899 | 100 | 100 | | | |
| 1904 | 122 | 124 | | | |
| 1909 | 159 | 158 | | | |
| 1914 | 170 | 186 | | | |
| 1919 | 214 | 222 | 100 | 100 | 100 |
| 1921 | 169 | 194 | 79 | 78 | 88 |
| 1923 | 263 | 280 | 120 | 120 | 126 |
| 1925 | 275 | 298 | 125 | 125 | 134 |
| 1927 | 274 | 317 | 126 | 132 | 143 |
| 1929 | 311 | 364 | 142 | 153 | 164 |
| 1931 | 206 | 262 | 95 | 103 | 118 |
| 1933 | 192 | 228 | 89 | 94 | 103 |
| 1935 | 233 | 301 | 107 | 121 | 136 |
| 1937 | 303 | 376 | 130 | 157 | 169 |

[a] This is the index computed for 1899–1914 by W. M. Persons and E. S. Coyle; for 1914–1925 by E. E. Day and Woodlief Thomas; for 1927–31 by Aryness Joy; for 1933–35 by V. S. Kolesnikoff; and for 1937 by C. L. Dedrick. See E. E. Day and Woodlief Thomas, *The Growth of Manufactures, 1899 to 1923* (Census Monograph VIII, Bureau of the Census, 1928), pp. 23, 34; V. S. Kolesnikoff, "Index of Manufacturing Production derived from Census Data, 1935," *Journal of the American Statistical Association* (Dec. 1937), pp. 713–14; and *Biennial Census of Manufactures: 1937*, Part I (Bureau of the Census, 1939), pp. 12, 17.

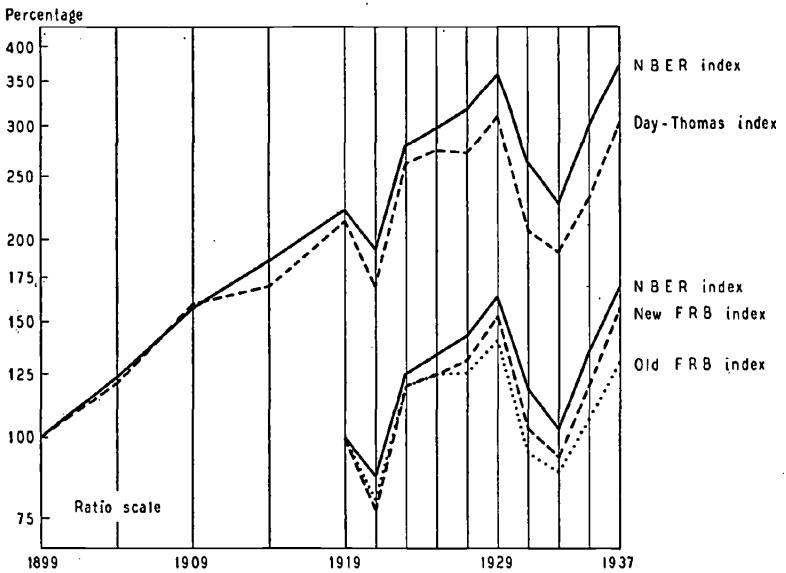
[b] Derived from Table 1.

[c] *Federal Reserve Bulletin* (July and August, 1940). The difference between the old and new indexes for 1921 is due entirely to the rounding of the figures, according to M. R. Conklin of the Board of Governors of the Federal Reserve System.

parisons of the indexes for the major groups and for some of the more important industries are made below, in Appendix D, but there has been no attempt to detect or to explain all the differences between the two indexes. It is probable, how-

ever, that much of the divergence arises from the lack of identity in the number and character of the manufacturing industries whose output was included in the computations. Our index is based on the greater number: 53 for 1899–1909, 65

Chart 2
ALL MANUFACTURING INDUSTRIES COMBINED
Comparison of NBER Index of Physical Output with Indexes Prepared by Other Agencies
(1899 or 1919 : 100)




for 1909–19, 74 for 1919–29 and 132 for 1929–37, while the basis of the Day-Thomas index is 26 industries for 1899–1909, 27 for 1909–14, 28 for 1914–19 and 49 for 1919–35.[5] Furthermore, many of the industries which we include, but which the Day-Thomas index omits, are the new and rising industries, such as rayon and rayon goods.

[5] Combinations, such as butter, cheese and canned milk, are treated as one industry in these enumerations. Lists of the industries are given in Appendix D. No information is available concerning the number of industries covered by the Day-Thomas index in 1937.

The old Federal Reserve index, not revised until August 1940, parallels closely the Day-Thomas index for 1919–33, so that it too rises less rapidly than the National Bureau index. From 1919 to 1937 our index goes up 69 percent, as compared with 30 for the unrevised Federal Reserve index. From 1929 to 1933 the old Federal Reserve index moves downward similarly to ours, but rises less rapidly from 1933 to 1937. From 1929 to 1937 our index records a net gain of 3 percent, whereas the old Federal Reserve index drops 8 to 9 percent.

The unrevised Federal Reserve index is fundamentally similar to the Day-Thomas index. Like the latter, it is based on a sample of old industries and does not cover the newer ones which have been advancing more rapidly. Unlike the Day-Thomas index it is confined to industries for which monthly data have been collected currently, although this added limitation has not given rise to any marked divergence between the two.

The new Federal Reserve index is a rather extensive revision of the old index for the period beginning with 1923. It covers many industries not previously included, and takes account of the output of industries for which monthly data on production are not available by utilizing biennial or annual indexes of output computed in the present and other studies and monthly indexes of man-hours of employment. It shows a rate of increase from 1919 to 1937 substantially higher than that indicated by the old Federal Reserve index, though somewhat lower than the rate revealed by the National Bureau index. According to Table 2 the figures are 157, 130 and 169 respectively. From 1919 to 1923 the rise is of course the same as that shown by the old index, and lower than the rise as measured by our index. Between 1923 and 1929 the new index indicates an increase of 27 percent as against 18 percent in the old index and 30 percent in the National Bureau index. The greatest difference between the old and new Federal Reserve indexes is found for 1929–37, with percentage in-

creases of −8.5 and +3 percent respectively. The latter figure is identical with that shown by our index.

During the course of the present study we worked out several different indexes in order to check the trend of manufacturing output indicated by the index in Table 1, which shows a rise of 276 percent from 1899 to 1937. In the alternative indexes, constructed by methods that differ in certain technical respects from the procedure followed in the preparation of the index in Table 1, the rises range from 238 percent to 318 percent for the period 1899–1937.[6] In view of the nature of the data and the length of the period covered, these differences are not large. Even the lowest figure obtained for 1937 is greater than the corresponding quantity shown by the Day-Thomas index. Moreover the test indexes are not all higher or lower than our standard figures; they are distributed around the latter.

## COMPARISON OF GROWTH IN PHYSICAL OUTPUT WITH POPULATION GROWTH

The gain in manufacturing output in 1899–1937 becomes still more significant if the advance is measured not merely in absolute terms but in comparison with population growth. The population of the United States increased in each of the 38 years between 1899 and 1937.[7] Since manufacturing output did not rise at a similarly steady rate, but instead moved rapidly upward in some years and downward in others, it is apparent at once that it must at times have fallen below the advance in population. Most of these periods were of short duration, but three of them were fairly long. Thus the advance in manufacturing faltered between 1907 and 1911, between 1916

[6] For a detailed discussion of the several procedures see Appendix A.

[7] The estimates for 1899–1910 are by W. I. King (unpublished); for 1910–31 by W. S. Thompson and P. K. Whelpton, *Recent Social Trends* (McGraw-Hill, 1933), Ch. 1, p. 3; and for 1930–37 by the Bureau of the Census, *Statistical Abstract of the United States, 1939,* p. 10.

and 1922 and between 1929 and 1937. During the last period, population rose 6 percent, whereas manufacturing output increased only 3 percent.

Over the period 1899–1937 taken as a whole, however, the rate of advance in manufacturing output was considerably more rapid than the rate of growth in population. Between the first year and the last the population of the United States increased from 75,000,000 to 129,000,000, or 73 percent. It grew, therefore, at an average annual rate of 1.4 percent. But manufacturing output gained 276 percent over these years, rising on the average 3.5 percent per annum—more than twice the rate of increase in population.

Although the record for the 38 years from 1899 to 1937 reveals a rise of 120 percent in manufacturing output per capita, it does not necessarily follow that there was an equivalent rise in the per capita consumption of finished processed goods, including not only consumers' goods but capital goods as well. As we explained in Chapter 2, our index of manufacturing output is constructed to reflect changes in the *net* output of manufacturing industries. It measures, in short, the changes in the value *added* to the materials consumed in manufacturing that are attributable to changes in the quantities of products and of materials consumed. In this index the output of each individual industry is evaluated by means of the value added per unit. The index does not measure changes in the aggregate quantity of *finished* goods, free of duplication and appraised in terms of the selling price of the final commodities issuing from the factory. It gives much more weight, for example, to a million dollars worth of finished automobiles than to a million dollars worth of meat products, because most of the value of the meat derives from the original value of the livestock slaughtered, whereas most of the value of the automobiles originates in the process of fabrication from relatively cheap iron ore and other products of nonmanufacturing industries.

Our index, then, measures the flow of finished manufactured goods not exactly but approximately. Furthermore, because manufacturing has moved toward increased fabrication of a given quantity of raw material, this index is probably biased upward as a measure of the output of finished goods.[8] In view of these qualifications, it is probable that the rise of 120 percent in the per capita net output of manufacturing industries from 1899 to 1937 overstates the gain in the per capita production of finished processed goods. An estimate of about 100 percent per capita would more closely approximate the increase in finished commodities turned out by our factories in that period, but this estimate is far from precise.[9]

One more reservation should be mentioned at this point: the undoubted rise in the per capita output of finished manufactures does not necessarily imply that the consumption of these goods increased at the same rate. One may infer such a parallelism only if changes in our foreign trade were slight or of negligible importance. Data available from 1913, and given in Table 3, indicate that exports and imports of manufactured goods fluctuated considerably in relation to the domestic production of manufactured goods.[10] The net excess of exports

[8] If the quantity of "fabrication" rises in relation to the quantity of input of raw materials, then the sum of these two quantities—the quantity of output of finished goods—will fall in relation to the quantity of fabrication.

The statement in the text that our index is biased upward as a measure of the output of finished processed goods is not inconsistent with the statement made earlier in this chapter that our index is biased downward as a measure of the net physical output of manufacturing industries.

[9] Figures compiled by W. H. Shaw of the National Bureau indicate that the physical volume of finished goods produced by manufacturing industries—including among finished goods not only consumers' goods but also capital equipment and construction materials—was approximately three and one-half times as great in 1937 as in 1899. Per capita, 1937 output of these goods was twice that of 1899. Mr. Shaw's figures will be published by the National Bureau in a forthcoming report.

[10] The indexes presented here cover semimanufactures as well as finished manufactures. Although the inclusion of semimanufactured goods among the imports is open to some question, the problem is of theoretical rather than of practical significance; the exclusion of semimanufactures would not seriously change either the index of imports or the conclusions drawn therefrom.

over imports rose more rapidly than domestic production between 1913 and 1929, and fell more rapidly between 1929 and 1937, a period when domestic production was rising slightly. Over the period 1913 to 1937, the excess of exports over imports declined in relation to domestic manufactures, and domestic consumption therefore rose more than domestic production. The difference between the trends was slight, however, for both exports and imports constituted relatively small fractions of domestic output and tended to balance each other. In 1914 the value of exports represented about 9 to 10 percent of the value of finished manufactured goods, and in 1929 the percentage was close to 8. The value of manufac-

TABLE 3

MANUFACTURED GOODS

Indexes of Physical Volume of Exports, Imports, and Exports minus Imports[a]

*(1923–25:100)*

| *Year* | *Exports* | *Imports* | *Exports minus Imports* |
|---|---|---|---|
| 1913 | 72 | 74 | 68 |
| 1919 | 124 | [b] | [b] |
| 1921 | 82 | 66 | 120 |
| 1923 | 94 | 98 | 85 |
| 1925 | 106 | 105 | 107 |
| 1927 | 120 | 112 | 137 |
| 1929 | 144 | 135 | 166 |
| 1931 | 86 | 93 | 71 |
| 1933 | 61 | 83 | 10 |
| 1935 | 79 | 103 | 23 |
| 1937 | 118 | 136 | 75 |

[a] Based on indexes of the U.S. Bureau of Foreign and Domestic Commerce, *Statistical Abstract* (1939), p. 472, and earlier issues of the *Abstract*. In the *Abstract* indexes are given individually for three groups: manufactured foodstuffs, semimanufactures and finished manufactures. These we combined by taking weighted arithmetic means of the individual indexes on the 1923–25 base. The weights were the average value of the exports or imports in the appropriate group in 1923–25 (*op. cit.*, pp. 474–75). The index of exports minus imports we computed by subtracting the weighted index of imports from the weighted index of exports, dividing by the difference between the weights, and multiplying by 100.

[b] Not available.

tured imports was below that of manufactured exports in these years. The difference, exports minus imports, was less than 3 percent of domestic production in 1914 and just about 3 percent in 1929.[11] Thus even considerable upward or downward relative trends in exports and imports would affect the relation between domestic production and domestic consumption only to a minor degree. We may conclude that the rise in the per capita production of finished manufactured goods, about 100 percent, was approximately equivalent to the rise in the per capita consumption of these goods.[12]

From the data thus far presented it is impossible to determine whether or not the gain in manufacturing output between 1899 and 1937 was at the expense of nonmanufacturing production. If manufacturing had simply robbed nonmanufacturing industry, the per capita increase in manufactured goods would represent nothing more than a change either in the character of the goods made available to each person or in the location of the productive process. Conceivably, it might be consistent not with an increase in the actual quantity of available goods but with a decline in that quantity: *total* output, including not only manufactures but also agricultural products, minerals, services of public utilities, construction, domestic services and so on, might have remained constant or even have dropped. We must admit that to some degree the increase in manufactures between 1899 and 1937 does appear to represent such a diversion of resources. Growth in agricultural output and in housewives' activities, for example, lagged behind population increase. These would seem to be the only important factors in the shift, though our information on nonmanufacturing production is too scanty at

[11] These figures are derived from computations by the Bureau of Foreign and Domestic Commerce, published in the *Statistical Abstract* (1938), pp. 435, 450–51.

[12] Although no indexes of the physical volume of exports and imports are available for years prior to 1913, data on their pecuniary volume in the earlier period indicate that this conclusion is valid for the entire period 1899–1937.

this time to warrant precise quantitative statement. Almost certainly, however, the greater part of the increase in manufacturing output reflects the expanding volume of our resources and the enhanced efficiency with which we have used them, and not merely the diversion to manufacturing of resources and energies formerly applied in other fields of industry and in the home. The rise in the per capita output of manufactures may be regarded, then, as a real addition to the volume of goods available to the average person.