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Chapter Title: 4 Trends In The Output Of Major Groups Of Manufacturing Industries

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Chapter 4

Trends in the Output of Major Groups of Manufacturing Industries

IN THE preceding chapter we were concerned with the aggregate output of American manufacturing industries and with the relationship of that rising volume to a population which also increased, but at a slower annual rate. In this chapter, which deals with the composition of the total volume of factory products, we shall trace the outstanding movements of the output of major groups of industries, and the shifts in production and consumption reflected in the altered makeup of the total.

CLASSIFICATION OF MANUFACTURING INDUSTRIES BY GROUPS

The Census of Manufactures distinguishes more than 300 manufacturing industries. These it classified in 1937 into 15 major groups according to three criteria: first, the primary material utilized in the industry, as in the case of the iron and steel products group; second, the process of manufacture, illustrated by the chemical products group; and third, the use made of the product, as in the case of the foods group. Since these three principles of classification are not mutually exclusive, the Census groups are subject to some degree of overlapping. Furthermore, no industry is placed in more than one group, so that the actual group classification presented in the Census involves some arbitrary decisions. Nevertheless, as it stands it is a valuable "general-purpose" arrangement and can easily be adapted to many specific uses.

The number and composition of the Census groups have varied from time to time. In an effort to keep the composition of each group constant throughout the period 1899-1937, we have shifted a few minor industries from the Census group in which they are now classified back to the group to which they had been allocated formerly. In addition, we have increased the number of groups from 15 to 17, promoting both beverages and tobacco products to group status by breaking down two of the original Census groups. The 17 groupings are listed in Table 4, which contains also brief notes concerning certain inclusions and exclusions.

The relative importance of each of the 17 groups is indicated in the table by its contribution to the total value added in 1923 by manufacturing industry as a whole.¹ Measured by this gauge, the most important group in 1923 was textiles, followed by machinery, and iron and steel products. These three groups, together, accounted for more than one third of the total value added by manufacturing industries in that year. It is well to remember, however, that a combination of iron and steel and nonferrous-metal products into a single group, metal products, or a breakdown of textile products into clothing and textile-mill products, or any one of a number of other changes in the classification would have altered the ranking substantially.

TRENDS IN THE PHYSICAL OUTPUT OF THE MAJOR GROUPS

The reader will note a number of gaps in the indexes for major groups (Table 5 and Chart 3). For two of them, machinery and miscellaneous products, the data were so fragmentary that no separate indexes could be constructed, and for four other groups the data covered only portions of the

¹ Percentages for other years are presented and discussed below.

TABLE 4

MAJOR GROUPS OF MANUFACTURING INDUSTRIES

With Measures of Importance in Terms of Value Added in 1923

<i>Group</i>	<i>Value Added in 1923^a</i>	
	Millions of Dollars	Percentage of the Total
Foods	2,346	9.8
Including related products, such as feeds, ice, and baking powder; excluding beverages		
Beverages	151	0.6
Including malt		
Tobacco products	528	2.2
Textile products	3,829	15.9
Including fur goods, artificial leather, linoleum, and oil cloth		
Leather products	797	3.3
Rubber products	457	1.9
Paper products	621	2.6
Including wood pulp		
Printing and publishing	1,532	6.4
Including allied activities, such as book-binding and engraving		
Chemical products	1,148	4.8
Excluding corn products, petroleum refining, turpentine and rosin, and other industries classified elsewhere		
Petroleum and coal products	572	2.4
Excluding manufactured gas		
Stone, clay and glass products	1,050	4.4
Forest products	1,888	7.8
Excluding wood pulp and wood distillation		
Iron and steel products	2,659	11.1
Excluding machinery and transportation equipment		
Nonferrous-metal products	851	3.5
Excluding machinery, transportation equipment, and aluminum		
Machinery	2,939	12.2
Excluding transportation equipment		
Transportation equipment	1,939	8.1
Excluding railroad repair shops		
Miscellaneous products	724	3.0
Chiefly musical instruments, brushes, professional and scientific instruments, mattresses, photographic supplies, and toys		
ALL GROUPS	24,031	100.0

^a Basic data on value added in all years are given in Appendix C.

TABLE 5

MAJOR GROUPS OF MANUFACTURING INDUSTRIES^aPhysical Output: Indexes and Percentage Changes^b

	<i>Foods</i>	<i>Bever- ages^c</i>	<i>Tobacco Products</i>	<i>Textile Products</i>	<i>Leather Products</i>	<i>Rubber Products</i>	<i>Paper Products</i>	<i>Printing and Publish- ing</i>
YEAR	INDEX OF PHYSICAL OUTPUT (1929:100)^c							
1899	30	43	30	38	64	..	18	17
1904	37	55	37	48	74	..	26	26
1909	45	63	43	60	83	..	37	36
1914	53	76	53	72	81	..	46	47
1919	65	23	69	67	90	54	53	54
1921	64	..	66	64	75	43	50	52
1923	80	..	74	82	95	72	70	73
1925	85	..	81	86	85	84	77	82
1927	90	..	90	94	97	92	89	90
1929	100	..	100	100	100	100	100	100
1931	91	..	93	87	80	70	86	84
1933	82	17	88	85	86	69	84	72
1935	92	70	101	99	100	79	102	87
1937	104	100	117	106	108	91	122	102
PERIOD	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT							
1899-1937	+244	+132	+293	+180	+69	..	+567	+494
1899-1909	+48	+46	+46	+60	+29	..	+100	+108
1909-1919	+45	-63	+60	+11	+9	..	+44	+52
1919-1929	+54	..	+44	+49	+11	+86	+89	+85
1929-1937	+4	..	+17	+6	+8	-9	+22	+2

^a Groups for which there are no adequate quantity data for any period listed above are machinery and miscellaneous products. These groups are covered by the total.

^b The indexes 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

period with which we are concerned.² We computed an index of output for an industry only if there were available quantity statistics for at least 40 percent of that industry's products (measured by value of products); and similarly we con-

² Because of the inadequacy of data for most groups, no attempt was made to interpolate annual indexes of production between the indexes for Census years.

YEAR	Chemical Products	Petro- leum Coal Products	Stone, Clay and Glass Products	Forest Products	Iron and Steel Products	Non- Ferrous Metal Products	Trans- portation Equip- ment	Total Manu- factur- ing
	INDEX OF PHYSICAL OUTPUT (1929:100) ^o							
1899	19	8.7	..	82	21	..	7.3	28
1904	23	10.2	..	76	29	..	7.5	34
1909	31	16	..	83	44	..	10.7	43
1914	42	21	..	82	48	..	20	51
1919	52	39	..	79	59	..	61	61
1921	42	41	..	83	46	..	38	54
1923	64	64	..	91	84	..	76	77
1925	70	75	91	103	87	79	76	82
1927	83	83	100	99	87	84	68	87
1929	100	100	100	100	100	100	100	100
1931	87	84	67	63	54	64	46	72
1933	84	78	47	46	45	47	33	63
1935	101	92	69	59	61	66	72	83
1937	124	114	100	76	89	89	91	103
PERIOD	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT							
1899-1937	+566	+1206	..	-7	+327	..	+1142	+276
1899-1909	+69	+85	..	+1	+110	..	+47	+58
1909-1919	+64	+143	..	-5	+34	..	+468	+41
1919-1929	+94	+156	..	+27	+70	..	+64	+64
1929-1937	+24	+14	0	-24	-11	-11	-9	+3

the indexes derived from them. The indexes have been adjusted to take account of changes in the coverage of the respective samples.

The percentage changes are not always entirely consistent with the indexes given above because the changes were computed from the indexes in Appendix B, which are carried to one decimal place.

^o The index for beverages is on the 1937 base.

structed an index for a group only if indexes were available for at least 40 percent of the industries in that group (measured by value added).

Foods, the first group in our list, augmented its physical output by about 50 percent in each of the first three decades of this century. Even in the troubled years from 1929 to 1937

Chart 3

MAJOR GROUPS OF MANUFACTURING INDUSTRIES

Indexes of Physical Output

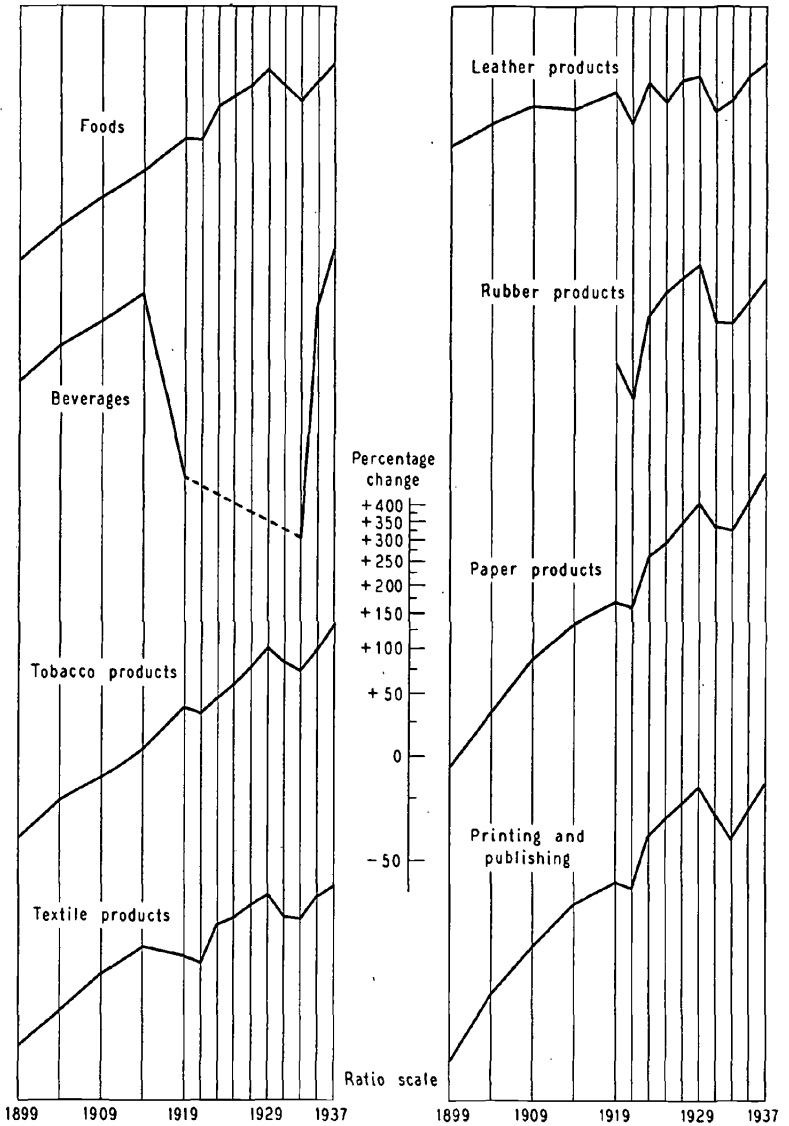
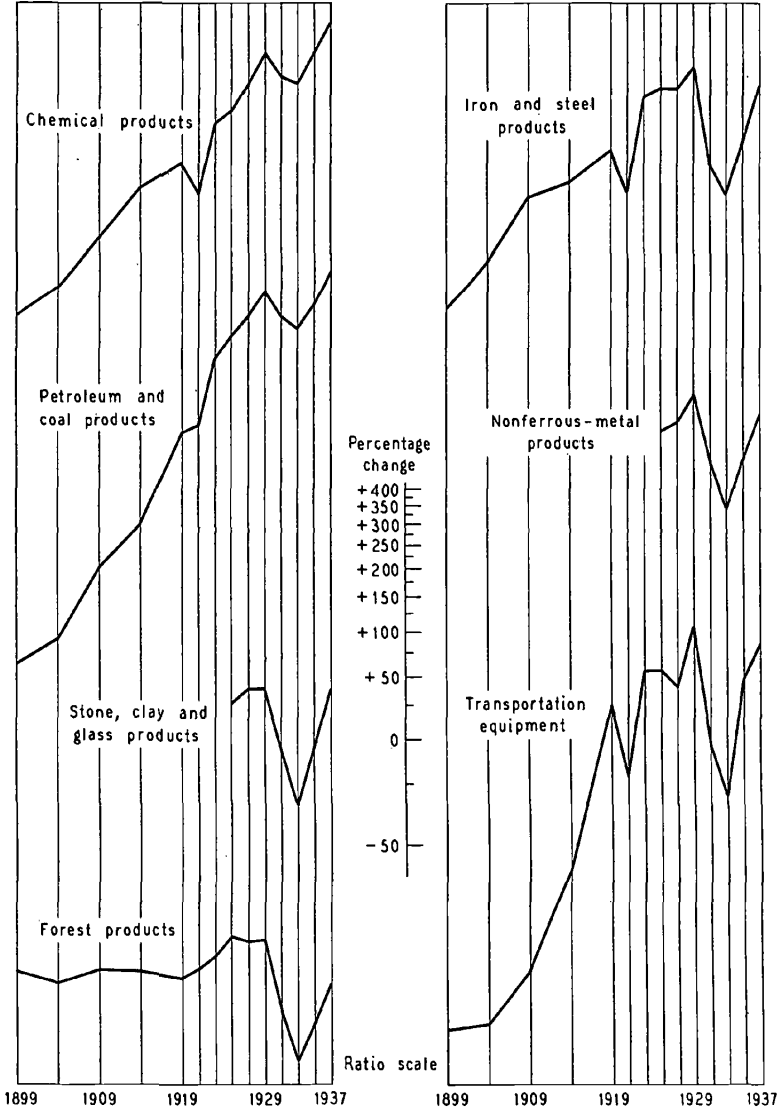


Chart 3 (concl.)

MAJOR GROUPS OF MANUFACTURING INDUSTRIES
Indexes of Physical Output



it attained a net increase of 4 percent. For the entire 38-year period the net rise in the factory production of foods reached almost 250 percent, not far short of the percentage gain in total manufacturing.⁸ In relation to the population increase of 73 percent from 1899 to 1937, factory food production rose very considerably. This rise does not, however, represent an equivalent increase in the per capita consumption of processed foods. An important factor contributing to the growth in the output of the food manufacturing group was the shift to the factory of food processing formerly carried out on the farm, in retail establishments and in the home. Such shifts were especially pronounced in butter production, canning and preserving, and baking; to a lesser degree they occurred also in the preparation of meats.

The physical output of the *beverages* group rose in the first decade by almost one half, keeping pace with foods and not far behind total manufacturing. The rise continued from 1909 to 1914, but was then followed by a severe decline from 1914 to 1919. The legal production of beverages was greatly affected, of course, by the passage of the prohibition amendment and its subsequent repeal. For the period 1919-33 no adequate index for the group can be computed because quantity data for nonalcoholic beverages, the principal industry of the group in that period, are not available. There is hardly any question, however, that the level of output of the group was exceedingly low during these years. Beginning with 1933 output rose at a very rapid pace. The rise brought production in 1937 to a level one third above that of 1914, the previous high point, and 130 percent above that of 1899. The net rise from 1899 to 1937 fell far short of the corresponding increase in total manufacturing, although it was greater than the growth of population in the same period. It is difficult to draw any conclusion regarding actual per capita consumption

⁸ Comparisons with changes indicated by the Day-Thomas indexes are presented in Appendix D.

from these data, since they exclude all illicit production of liquor. Aside from this fact, consumption does not necessarily equal production. Indeed in 1937 the fraction of output that was added to stocks for aging was rather large, much greater than the corresponding fraction in 1899. In other words, consumption was much smaller in relation to production in 1937 than was the case in 1899; therefore the rise in per capita production, in the years 1899 to 1937, was greater than the rise in per capita consumption.

The physical output of the *tobacco products* group rose by about one half in each of the first three decades. In the eight years following 1929 there was a gain of one sixth. The year 1937 found the factory production of tobacco products almost four times as great as it had been in 1899. This increase exceeded slightly the corresponding gains in total manufacturing and foods, and by a wide margin the rise in population. Over the entire period the per capita production of tobacco products more than doubled, although the quantity of tobacco consumed per capita increased by less than 50 percent. The disproportionately large increase in output is to be ascribed largely to a change in the smoking habits of the population. More highly processed tobacco products, especially cigarettes, acquired greater importance in tobacco diets. Factory production, which consists of the fabricational operations on the leaf, therefore rose more rapidly than the quantity of leaf tobacco used.

The *textile products* group, one of the most important of all manufacturing groups measured in terms of value added, made appreciable progress in the first and third decades of the four we are describing. In the last period also, the increase of 6 percent may be considered a fair advance. But the rise of 11 percent between 1909 and 1919 is exceedingly low as compared with the gain in total manufacturing. Even population rose more rapidly in this decade. The increase in textile production in the entire 38-year period, 180 percent, also was

slight in relation to total manufacturing. Textile production per capita increased only about 60 percent, surprisingly little in view of the shift from home and custom tailoring to the factory production of clothing.

Leather products advanced even less than textile products. To be sure, the gain of 8 percent from 1929 to 1937 was exceptionally high for a slump period, but in the two preceding decades the output of leather products had risen less than population, and even in the first decade, 1899-1909, the increase (29 percent) had barely exceeded population growth (21 percent). The 38-year gain, 69 percent, fell short of population growth over the same period, and far below that of total manufacturing. The drop in leather exports was one of the factors in the lag in leather output, and it is probable that the decline of saddlery and harness manufacture, the substitution of other materials for leather, and the shift of fashion from high to low shoes contributed even more to the reduction in the per capita production of leather goods.

The *rubber products* group almost doubled its output between 1919 and 1929, the earliest period for which we have adequate data on the physical quantity of rubber products, and decreased it by one tenth in the eight years following. Such clues as we find in data on value added in rubber manufacture, on rubber imports, and on the output of important consumers of rubber products, notably the automobile industry, indicate that the rise between 1909 and 1919 must have been of huge proportions. It is very likely, indeed, that during the 38 years between 1899 and 1937 the rate of increase in rubber goods production was double the rate for total manufacturing, and greatly exceeded the rise in the output of other semidurable goods like textiles and leather products.

The output of the *paper products* group advanced rapidly in each of the four periods. In the first it doubled, and in the third it almost doubled. In the second decade the increase,

while moderate, nevertheless exceeded the gain in total manufacturing. In the period between 1929 and 1937, when total manufacturing output rose only 3 percent, the paper group increased its production by more than 20 percent. In relation to population, the output of paper products almost quadrupled between 1899 and 1937. Much of this increase is attributable to the rise in printing and publishing, but other factors were the development of elaborate packaging of consumer goods, the shift from wood to paper in the manufacture of boxes and other containers, and the growing use of such articles as paper napkins and toilet paper.

The *printing and publishing* group also increased its output substantially. Except in the last period, when there was only a slight change, its growth paralleled closely that of paper products. In 1937 the output of the group was six times as large as it had been in 1899, an advance which must reflect in some degree the expansion of advertising during the 38 years.

The *chemicals* group raised its output by two thirds in both the first decade and the second, doubled it in the third, and increased it by a quarter in the last. The total gain from 1899 to 1937 was well over 500 percent. This rise was equivalent to the advance in paper products, considerably greater than the increase in total manufacturing, and very much greater than the growth in population. Most of the additions to the group's output are to be credited to two new industries, rayon and compressed and liquefied gases, to paints and varnishes, and to the collection of other industries whose importance is scarcely hinted at in the Census title "chemicals not elsewhere classified."

The output of the *petroleum and coal products* group rose at a phenomenal rate; it nearly doubled in the first decade, and more than doubled in each of the two following decades. Even in the period 1929-37 it increased 14 percent. In 1937 the group's output was 13 times as great as it had been in 1899. On the demand side this spectacular growth reflected prima-

rily the development of the automobile; and on the supply side it resulted from important technological advances in the extraction of gasoline from crude petroleum.

The output of the *stone, clay and glass products* group, on which data are available only from 1925, rose 9 percent from 1925 to 1927, and stood at the 1927 level in 1929 and 1937. It is difficult to estimate the long-period growth in the group's output not alone because of the inadequacy of the data, but also because the group includes rapidly growing industries like cement, and declining industries like clay products (brick) and marble and granite. From the incomplete evidence it appears that the declines in the latter industries, resulting from shifts in the types of materials used in building, were more than counterbalanced by the growth in cement and glass products. It is not unreasonable to conclude, therefore, that the group's output rose somewhat less rapidly than total manufacturing, though perhaps not so slowly as population.

The *forest products* group is outstanding because its output not only lagged behind that of total manufacturing but actually was smaller in 1937 than it had been in 1899. It failed to advance appreciably during the first decade and declined slightly during the second. Beginning with 1919, there set in a rise which culminated by 1925 in an increase of one third. There was little change from 1925 to 1929, but from 1929 to 1937 output fell by one fourth; in the latter year it was 7 percent below the 1899 level. Undoubtedly the chief cause of the decline in forest products was the displacement of lumber by other materials. In construction, and to some extent in furniture manufacture, lumber was supplanted in large measure by metal and other products. These substitutions, in turn, were set in motion by the depletion of forest reserves, the rapid technological developments in such competitive products as steel and cement, and the growing demand for materials sturdy enough for use in large structures.

Iron and steel products, which rank high among the basic materials used by contemporary industry, more than doubled in output in the first ten years of the century, rose by one third in the second decade, and by two thirds in the post-war decade. From 1929 to 1937 the group's output declined by a tenth. The net increase between 1899 and 1937 surpassed substantially the corresponding rise in total manufacturing. In this entire period the dominant position of iron and steel remained unchallenged because the declines in industries using the products were offset by the emergence of new industries that required these fundamental materials.

For the *nonferrous-metal products* group adequate data are available beginning only with 1925. From that year to 1929 the output of the group rose by one fourth, and from 1929 to 1937 it declined 10 percent. For the period 1899-1937 as a whole the statistical materials for a rough estimate of the trend in the group's output are somewhat more adequate than in the case of stone, clay and glass products. The industries for which we have data on physical output—the three primary smelting and refining industries, copper, zinc and lead—increased their combined physical output by 200 percent during the 38 years. It is probable, however, that the products of the fabrication processes following upon the primary smelting and refining stage, and carried on by other industries in the group, grew more rapidly than the products of the primary process. The occurrence of this growth is indicated, though not measured exactly, by the decline in exports of primary metals and the increase in the output of secondary metals, and is revealed also by the data on value added. It is probable that the total output of the group rose more than 200 percent.

For *machinery* too our data are incomplete. The great number of machinery products, their vast complexity, and the rapid changes in their quality have made impossible the construction of an adequate index of output. If we may judge from rough estimates by W. H. Shaw, who deflated the value

of machinery production by the few price series that could be obtained, the group increased its physical output about 30 percent more rapidly between 1899 and 1937 than did all manufacturing industries combined. Data on value added indicate a relative rise of 50 percent. According to estimates similarly derived, the machinery group rose by the same amount as total manufacturing from 1929 to 1937; that is, machinery output in 1937 was only slightly higher than it was in 1929. Though the precision of the figures quoted is open to question, there can be little doubt that the output of the machinery industries increased, from 1899 to 1937, more rapidly than the output of most other manufacturing groups, and that output in 1937 was relatively as high as it had been in 1929.

The output of *transportation equipment*, which includes automobiles, railroad equipment, ships and boats, and a few other industries, increased at a highly varying rate. In the first decade the rise was somewhat less than that in total manufacturing. In the following ten years, however, transportation equipment more than quintupled, whereas total manufacturing rose less than one half. Between 1919 and 1929 the group kept pace with the total; both increased by about two thirds. From 1929 to 1937, a period when total manufacturing was increasing slightly, there was a decline of almost 10 percent in the group's output. By 1937 the physical output of transportation equipment was more than 12 times as great as it had been in 1899.⁴ The behavior of this group was determined

⁴ It should be remembered that the indexes in Table 5 are chains of four links, 1899-1909, 1909-19, 1919-29 and 1929-37. If output in 1899 and in 1937 were compared directly, with the average of the two years as the weight-base (see Chapter 2), the percentage change in the output of transportation equipment between 1899 and 1937 thus derived would be +750 instead of +1,140 as Table 5 shows. The discrepancy is attributable to the extreme diversity, among the component industries, of trends in physical output and in value added per unit of physical output. No discrepancy of this magnitude appears when the index of any other group is computed by both methods. The differences are discussed in Appendix A.

primarily by the course of automobile production. Indeed, of the five transportation-equipment industries for which we have complete indexes, the automobile industry was the only one that showed a net increase in output from 1899 to 1937. Part of the great rise from 1914 to 1919 was due also to the war-time development of the shipbuilding industry; the decline in that industry and in railroad equipment served to moderate the gain in the output of the group in the post-war decade.

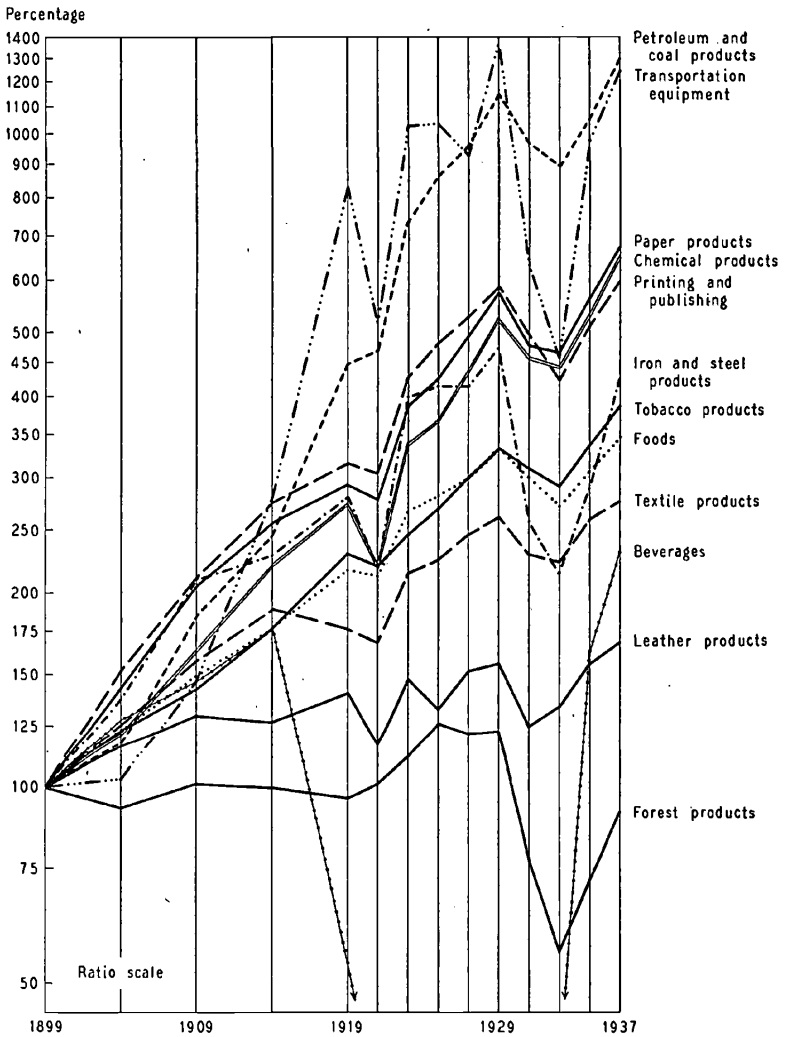
The substantial differences among the trends in the physical output of the major groups of manufacturing industries are shown in bold relief in Chart 4, where the indexes for the period 1899–1937 are started from a common point—1899. This view of the trends in the component elements of manufacturing output, restricted though it is to major groups, nevertheless shows wide variety. Yet, as we shall see in the next chapter, this amazing diversity does not even approach the divergence in the trends of individual industries.

In the most recent period, 1929–37, when the aggregate output of all manufacturing industries rose only 3 percent, the greatest percentage increase for any single group was attained by beverages as a result of the repeal of prohibition.⁵ Chemical products came next, with a gain of about 25 percent, followed closely by paper products, with an increase of 22 percent. Tobacco products rose 17 percent, and petroleum and coal products 14 percent. Leather products, textile products, foods, and printing and publishing all gained between 2 and 8 percent. It is probable that machinery output increased slightly between 1929 and 1937.⁶ The six remaining groups declined. Stone, clay and glass products were affected but slightly. More serious were the decreases of around one tenth in rubber products, iron and steel, nonferrous metals, and transportation equipment. Most severe was the drop in forest products:

⁵ No exact figures are available.

⁶ For this group, too, no exact figures can be given.

Chart 4
 GROUPS OF MANUFACTURING INDUSTRIES
 Indexes of Physical Output
 (1899 = 100)



the output of this group fell by almost one fourth. With the exception of rubber products, all the industrial groups whose output declined from 1929 to 1937 were those engaged largely in the production of building materials and metal products. Most of the durable goods industries appear to have been the losers in this period; it is noteworthy, however, that machinery was not among them.

Forest products was the only major manufacturing group whose output was lower in 1937 than it had been in 1899. Only forest products and leather products lagged behind population growth in this long period; the rest exceeded it in varying degree.

CHANGES IN THE RELATIVE IMPORTANCE OF THE MAJOR MANUFACTURING GROUPS

The divergence of the trends in the output of the several groups of manufacturing industries resulted in profound changes in the pattern of output of all manufacturing industries combined. Declines in forest products and low rates of growth in leather products, on the one hand, and extremely high rates of increase in transportation equipment and petroleum products, on the other, meant that in the flow of goods from manufacturing plants in 1937 there was a larger representation of automobiles, gasoline and coke than there had been in 1899, and a smaller proportion of lumber, leather and shoes. The change is depicted graphically in Chart 5, which shows the indexes given in Table 5 expressed as percentages of the index of total manufacturing output. The relative changes thus brought out are presented in numerical form in Table 6. The relative movements in physical output may be checked by corresponding indexes derived for pecuniary output, as measured by value added. These also are cited in the chart, and in numerical form in Table 7. The measures of value added supply approximate information on the rela-

Chart 5

CHANGING PATTERN OF MANUFACTURING OUTPUT

Indexes of Physical Output and of Value Added for Major Groups Expressed as Percentages of the Corresponding Indexes for Total Manufacturing

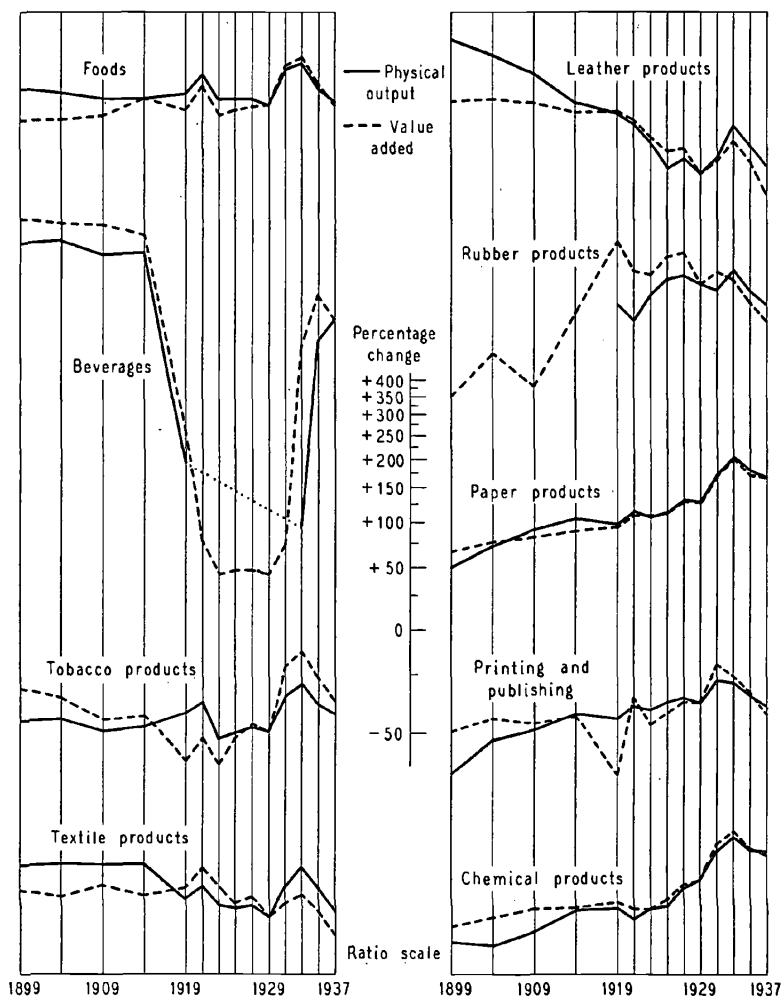


Chart 5 (concl.)

CHANGING PATTERN OF MANUFACTURING OUTPUT

Indexes of Physical Output and of Value Added for Major Groups Expressed as Percentages of the Corresponding Indexes for Total Manufacturing

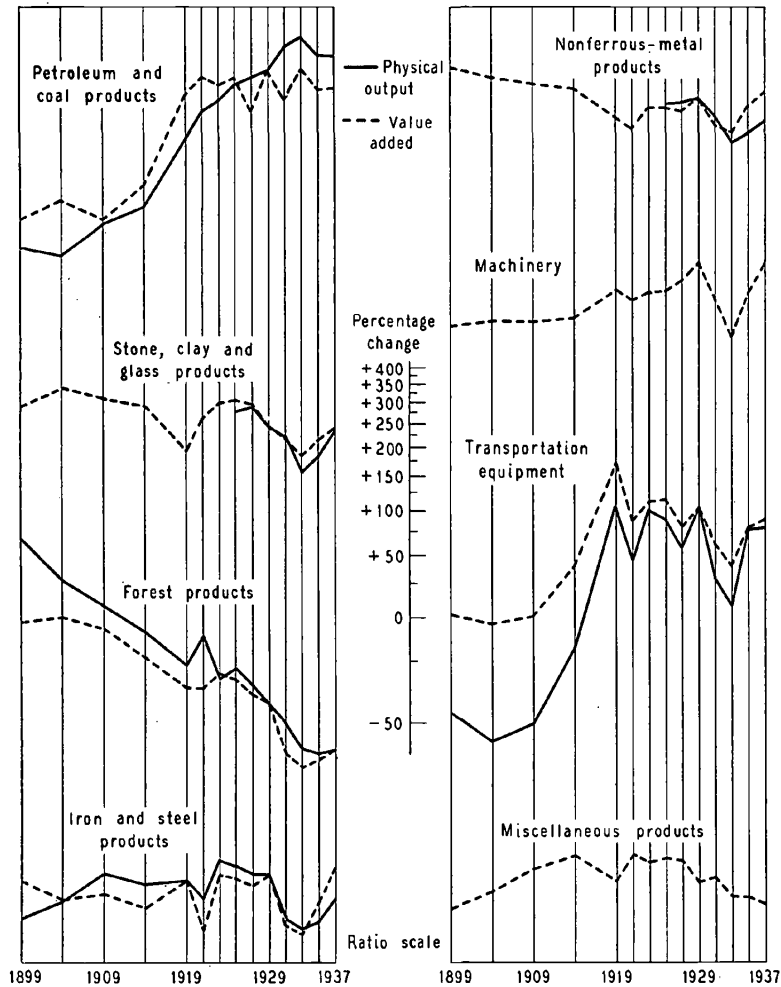


TABLE 6

CHANGES IN THE PATTERN OF MANUFACTURING OUTPUT

Indexes of Physical Output for Major Groups Expressed as Percentages of the Corresponding Index for Total Manufacturing^a

	<i>Foods</i>	<i>Bever- ages^b</i>	<i>Tobacco Products</i>	<i>Textile Products</i>	<i>Leather Products</i>	<i>Rubber Products</i>	<i>Paper Products</i>	<i>Printing and Pub- lishing</i>
YEAR	INDEX (1929:100) ^b							
1899	110	162	108	138	233	..	66	62
1904	108	165	109	140	216	..	76	77
1909	104	151	100	139	191	..	85	82
1914	104	153	103	141	158	..	91	92
1919	107	39	114	110	148	88	87	88
1921	121	..	124	121	139	80	94	98
1923	104	..	96	107	123	94	91	95
1925	104	..	99	105	103	103	94	100
1927	104	..	103	107	111	106	102	104
1929	100	..	100	100	100	100	100	100
1931	126	..	129	120	111	96	120	117
1933	131	26	140	136	137	110	135	115
1935	112	88	122	120	120	96	123	105
1937	101	100	114	103	105	88	118	98
PERIOD	NET PERCENTAGE CHANGE ^c							
1899-1937	-8	-38	+5	-25	-55	..	+78	+58
1899-1909	-6	-7	-8	+1	-18	..	+27	+32
1909-1919	+3	-74	+14	-21	-23	..	+2	+8
1919-1929	-6	..	-12	-9	-32	+14	+16	+13
1929-1937	+1	..	+14	+3	+5	-12	+18	-2

^a Derived from Table 5.^b For beverages the base is 1937.^c The percentage changes are not always entirely consistent with the indexes

tive growth of machinery and miscellaneous products, for which we have no precise measures of physical output, and also on the relative growth of the groups for which our indexes of physical output are incomplete.

The long-run relative trends in physical output and in the value added in the fabrication of that output are in close correspondence in respect of rank, as the table at the top of

YEAR	Chemical Products	Petroleum and Coal Products	Stone, Clay and Glass Products	Forest Products	Iron and Steel Products	Nonfer- rous- Metal Products	Trans- portation Equipment
	INDEX (1929:100) ^b						
1899	68	32	..	298	76	..	26
1904	66	30	..	224	84	..	22
1909	72	37	..	191	101	..	25
1914	83	42	..	161	94	..	40
1919	84	64	..	129	97	..	100
1921	78	76	..	156	85	..	71
1923	84	83	..	118	110	..	98
1925	85	92	111	126	106	97	93
1927	95	96	114	114	100	97	78
1929	100	100	100	100	100	100	100
1931	121	117	94	88	76	89	64
1933	133	124	75	74	71	75	53
1935	122	111	83	72	74	80	87
1937	120	110	96	74	86	87	88
	NET PERCENTAGE CHANGE ^c						
1899-1937	+77	+248	..	-75	+14	..	+231
1899-1909	+7	+17	..	-36	+33	..	-7
1909-1919	+17	+73	..	-33	-4	..	+304
1919-1929	+18	+56	..	-22	+4	..	0
1929-1937	+20	+10	-4	-26	-14	-13	-12

given above because the changes were computed from indexes carried to one decimal place.

page 80 shows.⁷ Despite the absence of quantity indexes, this correspondence provides some ground for the supposition that the fraction of the aggregate of manufacturing output repre-

⁷ The coefficient of rank correlation is +0.97.

The indexes of physical output are the indexes adjusted, on the basis of value added, for changes in the coverage of the samples. The adjustment did not result in a spurious correlation between physical output and value added. If we correlate the unadjusted indexes with value added, we obtain a coefficient only slightly less, +0.96.

TABLE 7

CHANGES IN THE PATTERN OF VALUE ADDED IN MANUFACTURING

Indexes of Value Added for Major Groups Expressed as Percentages of the Corresponding Index for Total Manufacturing^a

YEAR	INDEX (1929:100) ^b								
	Foods	Bever- ages ^b	Tobacco Products	Textile Prod- ucts	Leather Prod- ucts	Rubber Products	Paper Prod- ucts	Print- ing and Pub- lishing	Chem- ical Products
1899	91	191	136	118	160	49	74	82	75
1904	91	184	126	113	162	65	78	89	79
1909	94	183	109	122	158	52	80	86	83
1914	105	172	112	114	149	84	84	90	84
1919	98	49	82	120	149	131	86	62	87
1921	113	24	96	136	140	109	93	104	84
1923	94	19	81	121	129	107	92	86	83
1925	98	20	97	108	116	120	94	94	88
1927	100	20	106	113	118	122	102	101	97
1929	100	19	100	100	100	100	100	100	100
1931	129	24	157	109	109	108	120	129	127
1933	136	84	174	115	124	103	134	120	138
1935	113	116	146	104	108	90	119	109	123
1937	100	100	125	89	89	79	118	94	118
PERIOD	NET PERCENTAGE CHANGE ^c								
1899-1937	+10	-48	-8	-24	-44	+61	+60	+14	+58
1899-1909	+3	-4	-20	+4	-1	+7	+9	+5	+11
1909-1919	+4	-73	-24	-2	-5	+150	+7	-28	+5
1919-1929	+3	-60	+21	-17	-33	-24	+17	+62	+14
1929-1937	0	+416	+25	-11	-11	-21	+18	-6	+18

^a Derived from data collected in the U. S. Census of Manufactures. See Appendix C.^b For beverages the base is 1937.

sented by nonferrous-metal products⁸ and by stone, clay and glass products declined; that the fraction represented by miscellaneous products remained approximately constant; and that the fraction represented by machinery and rubber products rose.

⁸ Note, however, the preceding discussion, p. 69.

YEAR	Petro- leum and Coal Products	Stone, Clay and Glass Products	Forest Prod- ucts	Iron and Steel Products	Nonfer- rous- Metal Prod- ucts	Machin- ery	Trans- portation Equip- ment	Miscel- laneous Prod- ucts
	INDEX (1929:100) ^b							
1899	38	115	172	96	122	67	50	85
1904	43	128	178	85	114	68	47	94
1909	38	120	164	89	109	68	50	109
1914	48	115	135	82	106	70	68	118
1919	85	86	111	96	89	85	132	101
1921	96	106	110	71	82	79	91	119
1923	91	117	122	101	94	83	103	114
1925	96	119	117	98	94	84	104	116
1927	78	116	106	94	92	90	88	115
1929	100	100	100	100	100	100	100	100
1931	83	94	72	72	84	80	79	103
1933	102	83	66	69	80	62	69	91
1935	89	92	68	85	95	81	87	91
1937	90	99	74	105	103	100	93	87
	NET PERCENTAGE CHANGE ^c							
1899-1937	+133	-13	-57	+9	-15	+50	+85	+3
1899-1909	0	+5	-5	-8	-11	+2	-1	+28
1909-1919	+123	-28	-32	+8	-18	+25	+166	-7
1919-1929	+17	+16	-10	+4	+13	+18	-24	-1
1929-1937	-10	-1	-26	+5	+3	0	-7	-13

^c The percentage changes are not always entirely consistent with the indexes given above because the changes were computed from indexes carried to one decimal place.

The dispersion in the two columns of the tabulation on page 80 is worth noting also. With three exceptions, the relative changes in value added are smaller, without regard to sign, than are the relative changes in physical output. This finding, together with the positive correlation, suggests that net pecuniary receipts rose less rapidly than physical output in

Group	Percentage Change in Relation to Total Manufacturing, 1899 to 1937	
	Physical Output	Value Added
Forest products	-75	-57
Leather products	-55	-44
Beverages	-38	-48
Textile products	-25	-24
Nonferrous-metal products	..	-15
Stone, clay and glass products	..	-13
Foods	-8	+10
Tobacco products	+5	-8
Miscellaneous products	..	+3
Iron and steel products	+14	+9
Printing and publishing	+58	+14
Machinery	..	+50
Chemical products	+77	+58
Paper products	+78	+60
Rubber products	..	+61
Transportation equipment	+231	+85
Petroleum and coal products	+248	+133

the growing industrial groups; and fell less rapidly than physical output in the laggard groups.⁹

The relative contribution of any group to the aggregate physical output of manufacturing industries in a particular year may be expressed as a percentage of the total in that year. Such percentages describe the pattern of output in a given year, and changes in them measure changes in the pattern.¹⁰ Comparison of these percentages (as in Table 8) is

⁹ The implication is considered in greater detail in Chapter 5.

¹⁰ See A. F. Burns, *Production Trends in the United States since 1870* (National Bureau of Economic Research, 1934), pp. 49-50. The various kinds of physical output are rendered commensurate by means of the unit value added. By physical output, therefore, we mean value added to output, at fixed prices. These fixed prices are the averages or sums (the result is the same) of the prices prevailing in the two years that are compared with each other; for this reason the percentage contribution to total output computed for an industry for a particular year depends on the other year with which it is compared.

In symbols, the physical output of an industry in any year, say 1919, comparable with any other year, say 1929, is

$$\Sigma q_{19} (p_{19} + p_{29}) .$$

The physical output of any group is the sum of the physical output of the component industries, and is indicated by the prefixing of another summation

TABLE 8

Relative Contributions of Major Groups of Manufacturing Industries to the Physical Output of All Manufacturing Industries Combined^a

Group	Percentage Distribution, Comparable Pairs of Years									
	1899	1937	1899	1909	1909	1919	1919	1929	1929	1937
Foods	10.0	9.6	9.7	9.1	9.6	9.9	10.6	9.9	10.4	10.4
Tobacco products	3.5	3.6	3.5	3.2	2.3	2.6	2.6	2.3	2.8	3.2
Textile products	16.2	11.5	15.8	15.9	18.8	14.4	15.3	13.8	12.4	12.7
Leather products	4.6	2.1	4.6	3.7	4.6	3.6	3.8	2.6	2.4	2.5
Paper products	1.9	3.4	1.9	2.4	2.3	2.3	2.4	2.8	2.8	3.3
Printing and publishing	5.1	8.3	5.6	7.4	4.9	5.3	5.5	6.2	7.3	7.2
Chemical products	4.0	7.1	4.4	4.7	4.4	5.1	5.0	5.9	5.7	6.8
Petroleum and coal products	0.8	2.7	0.9	1.1	1.2	2.0	2.0	3.1	2.4	2.6
Forest products	16.4	4.2	14.0	9.0	10.5	7.1	7.6	5.9	6.4	4.7
Iron and steel products	10.0	11.5	8.7	11.6	10.4	9.9	10.4	10.8	11.9	10.3
Transportation equipment	3.4	8.0	4.1	3.8	2.9	11.9	9.3	9.3	8.1	7.1
Rubber products							2.0	2.3	1.7	1.5
Stone, clay and glass products							24.3		3.8	3.7
Nonferrous-metal products									4.1	3.6
Machinery									17.8	20.4
Miscellaneous products	5.5	3.7	6.5	6.0	6.1	1.6	23.5	25.1		
Beverages	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL ^b		18.6	20.4	22.1	22.0	24.3				

^a Derived from Table 5. For an explanation of the derivation of the measurements see footnote 10 above.

^b The columns do not add up to 100.0 in every instance because they contain rounded percentages.

in some respects more satisfactory than comparison of rates of growth, because the importance of each component is taken into account in the former procedure.¹¹ A moderate change in the relative contribution of an important group should, for some purposes, receive as much weight as a large change in the relative contribution of a small group, or possibly even more weight.

The arithmetic changes in the percentages between 1899 and 1937, given in Table 8, are ranked in order of magnitude in the tabulation on page 83. They are accompanied by the percentage changes in the percentages, given in the last column.¹² The latter summarize the sort of information that can be obtained from a comparison of rates of growth like that presented in Table 6.¹³ According to Table 8, transportation

sign to the preceding expression. The 1919 physical output of an industry that is comparable with 1909 is

$$\frac{\sum q_{19} (p_{19} + p_{09})}{\sum \sum q_{19} (p_{19} + p_{09})}.$$

The percentage contribution of the industry in 1919, then, is

$$100 \cdot \frac{\sum q_{19} (p_{19} + p_{29})}{\sum \sum q_{19} (p_{19} + p_{29})},$$

which is comparable with similar percentages computed for 1929; or

$$100 \cdot \frac{\sum q_{19} (p_{19} + p_{09})}{\sum \sum q_{19} (p_{19} + p_{09})},$$

which is comparable with 1909.

¹¹ The importance of each component depends to some extent, however, on the classification. Thus beverages might be combined with foods into a single group called "foods, including beverages." The latter would then be more "important," in terms of value added, than either of the two now treated separately.

¹² Thus the relative contributions of transportation equipment in 1899 and 1937 are given in Table 8 as 3.4 and 8.0, respectively. The arithmetic change from 1899 to 1937 is $8.0 - 3.4 = +4.6$; the percentage change from 1899 to 1937 is

$$100 \frac{8.0 - 3.4}{3.4} = +135.$$

¹³ They differ from the percentages given in Table 6, slightly in most cases, and considerably in the case of transportation equipment. The 1899-1937 percentage changes given in Table 6 were derived from chains of four links: 1899-1909, 1909-1919, 1919-1929 and 1929-1937. The first two columns in Table 8 were derived from a direct comparison of 1899 and 1937. See footnote 4, above. For a more detailed explanation see Appendix A.

equipment achieved a larger increase than any other group: its output rose from 3.4 to 8.0 percent during the 38 years between 1899 and 1937. The printing and publishing group was second, with a rise of 3.2 points. The comparison of rates of

<i>Group</i>	<i>Change in Relative Contribution, 1899-1937</i>	
	<i>Arithmetic</i>	<i>Percentage</i>
Transportation equipment	+4.6	+135
Printing and publishing	+3.2	+63
Chemical products	+3.1	+77
Petroleum and coal products	+1.9	+238
Paper products	+1.5	+79
Iron and steel products	+1.5	+15
Tobacco products	+0.1	+3
Foods	-0.4	-4
Beverages	-1.8	-33
Leather products	-2.5	-54
Textile products	-4.7	-29
Forest products	-12.2	-74

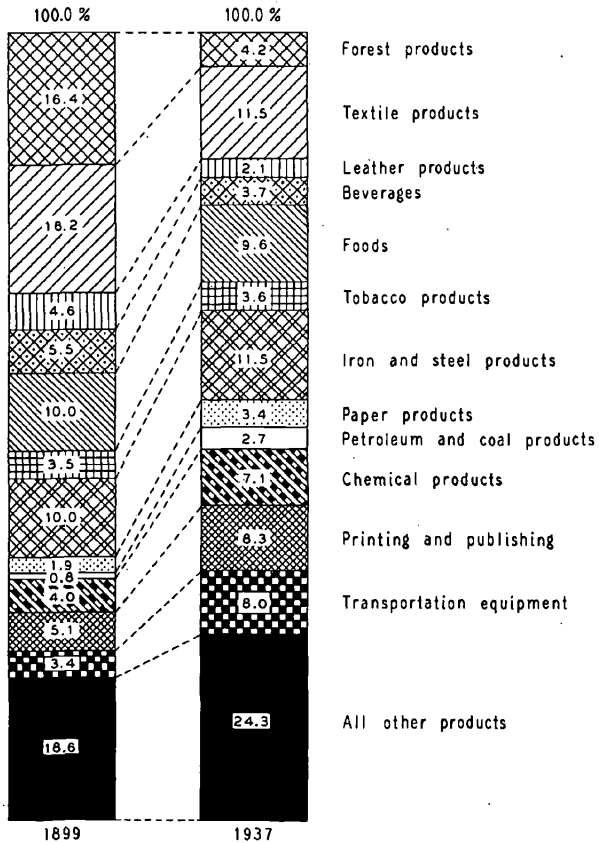
growth shows, however, that petroleum and coal products came first and transportation equipment second. Among the declines, the fall in the contribution of textile products, although slower than the drop in leather and beverages, appears to have had a greater effect upon the pattern of total manufacturing output than the declines in the two latter groups. The percentage contributions for 1899 and 1937 are shown in graphic form in Chart 6.¹⁴

A rough notion of the relative position of machinery and

¹⁴ Comparison of the two 1909 columns, the two 1919 columns, and the two 1929 columns in Table 8 reveals that the values in the second column are higher than those in the first in as many as 17 instances. Of these, 11 are associated with declines in the percentages during the decade ending in the year to which the columns relate. For example, the second 1909 percentage for foods is 9.6, which is higher than the first 1909 percentage, 9.1; and this is associated with a decline during the decade 1899-1909. The values in the second column are lower in 15 instances, and 10 of these are associated with rises in the decade ending in the year to which the columns refer. These relations reflect a negative correlation between direction of movement of physical output and direction of movement of value added per unit. This finding is closely connected with the point made earlier concerning the less marked dispersion of relative changes in value added than of relative changes in physical output. The correlation is studied in a more direct manner in Chapter 5.

Chart 6

PATTERN OF PHYSICAL OUTPUT OF MANUFACTURING INDUSTRIES, IN TERMS OF MAJOR GROUPS

Percentage Distribution of Total Physical Output
1899 and 1937

miscellaneous products in all years, and of beverages, rubber products, stone, clay and glass products, and nonferrous-metal products in those years for which physical quantities are lacking, may be obtained from data on value added (Table 9). The contributions to value added confirm, in broad outline,

the movements noted for physical output. Among the largest declines in both sets of measures are those in forest products, textiles and beverages; and among the largest rises are the gains in transportation equipment and in chemical products.

The most interesting information to be found in Table 9 relates to the machinery group. According to the figures, the

TABLE 9

Relative Contributions of Major Groups of Manufacturing Industries to the Value Added by All Manufacturing Industries Combined^a

Group	<i>Percentage Distribution, Comparable Pair of Years</i>							
	1899	1909	1909	1919	1919	1929	1929	1937
Foods	9.2	9.5	9.7	10.1	10.1	10.1	10.4	10.4
Beverages	6.3	6.1	6.1	1.6	1.6	0.6	0.6	3.3
Tobacco products	3.7	3.0	3.0	2.3	2.2	2.7	2.7	3.4
Textile products	15.5	16.1	16.0	15.8	15.9	13.2	13.2	11.8
Leather products	4.1	4.1	4.0	3.8	3.8	2.6	2.6	2.3
Rubber products	0.9	0.9	0.9	2.3	2.3	1.8	1.8	1.4
Paper products	2.0	2.2	2.2	2.4	2.4	2.8	2.8	3.3
Printing and publishing	6.2	6.5	6.5	4.7	4.6	7.4	7.4	7.0
Chemical products	4.3	4.8	4.8	5.0	5.0	5.8	5.8	6.8
Petroleum and coal products	1.0	1.0	1.0	2.2	2.2	2.6	2.6	2.3
Stone, clay and glass products	4.3	4.5	4.5	3.2	3.2	3.7	3.7	3.7
Forest products	11.2	10.6	10.6	7.2	7.1	6.4	6.4	4.7
Iron and steel products	10.4	9.6	9.7	10.5	10.4	10.8	10.8	11.3
Nonferrous-metal products	4.6	4.1	4.1	3.3	3.3	3.8	3.8	3.9
Machinery	10.0	10.2	10.0	12.5	12.6	14.9	14.9	14.8
Transportation equipment	4.0	3.9	3.9	10.3	10.4	7.9	7.9	7.3
Miscellaneous products	2.2	2.9	2.9	2.7	2.6	2.6	2.6	2.3
TOTAL ^b	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

^a Basic data are given in Appendix C.

^b The columns do not add up to 100.0 in every instance because they contain rounded percentages.

relative importance of the group rose in each of the first three decades and declined only minutely in the last period. Indeed, if we go beyond the table to the detailed data available for

each Census year,¹⁵ we find that the relative contribution of the machinery group rose in as many as 9 out of 13 pairs of contiguous Census years. The exceptions were 1904-09, when the contribution remained constant, and the cyclical recessions 1919-21, 1929-31 and 1931-33, when there were declines. There was a net rise, from 1899 to 1937, of close to five points, which was greater than the net rise between these two years in any other group. In terms of value added, machinery was definitely more important among our manufactures in 1937 than it had been in 1899; and the probabilities are that it was more important also in terms of physical output. In the advance of this group of industries we find one basic reason for the growth in total manufacturing and in the economy at large.

¹⁵ Appendix C.