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Volume Title: The Output of Manufacturing Industries, 1899-1937

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Volume Publisher: NBER

Volume ISBN: 0-87014-038-8

Volume URL: <http://www.nber.org/books/fabr40-1>

Publication Date: 1940

Chapter Title: The Output of Individual Manufacturing Industries:
Transportation Equipment

Chapter Author: Solomon Fabricant

Chapter URL: <http://www.nber.org/chapters/c6429>

Chapter pages in book: (p. 301 - 316)

Transportation Equipment

THE transportation equipment group consists of industries engaged primarily in the manufacture of aircraft, vehicles for land transportation, and watercraft. Railroad equipment manufactured in repair shops operated by railroads is not included.

In 1899 the transportation equipment group was one of the less important manufacturing groups. Ranked according to value added, it stood among the lowest six. In 1937, however, the contribution of transportation equipment to total value added was greater than that of twelve other groups.

TRENDS IN THE PHYSICAL OUTPUT OF THE TRANSPORTATION EQUIPMENT INDUSTRIES

Automobiles increased in output at a phenomenal rate (Table 62, Chart 23). Output in 1937 was 1,800 times as great as it had been in 1899. In the first decade it increased 3,500 percent, in the next almost 1,500 percent, and in the third about 250 percent; in the last period, 1929-37, it declined 10 percent.¹ The speed with which an important industry can attain maturity in our economic system cannot be illustrated more strikingly than here.

¹ The index is based on the output of new cars and chassis only; replacement parts are not included. It is probable, therefore, that the trend shown by the index understates the trend in the total output of the industry. Perhaps more important in terms of general economic significance, are the cyclical defects of the index, which is biased downward for recession periods and upward for recovery periods: replacement parts do not fall off in output as much as new cars do during recession, nor do they rise as much during recovery. No adequate data on the production of parts for replacement are available; for rough estimates see Magdoff, Siegel, and Davis, *op. cit.*

TABLE 62

TRANSPORTATION EQUIPMENT^aPhysical Output: Indexes and Percentage Changes^b

YEAR	Automobiles, incl. Bodies and Parts	Carriages, Wagons and Sleighs	Cars, Railroad, n.e.m. ^c	Locomotives, n.e.m. ^c	Stiffs and Boats ^d	Motorcycles and Bicycles	Carriages and Sleds, Children's	Total	
								Unadjusted	Adjusted
1899	0.05	1,317	119	264	97	141	..	6.9	7.3
1904	0.2	1,392	122	366	80	32	..	7.1	7.5
1909	1.8	1,333	114	282	74	64	..	10.2	10.7
1914	8.5	1,123	154	204	74	121	..	20	20
1919	28	647	171	321	551	180	..	62	61
1921	25	182	96	175	213	81	..	38	38
1923	63	300	229	412	99	128	..	76	76
1925	72	216	139	137	90	98	92	77	76
1927	63	173	101	105	110	87	90	68	68
1929	100	100	100	100	100	100	100	100	100
1931	44	36	31	23	78	..	71	45	46
1933	35	40	..	..	23	..	59	34	33
1935	74	59	30	..	..	..	70	71	72
1937	90	71	93	55	80	..	89	89	91
INDEX OF PHYSICAL OUTPUT (1929:100)									
NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT									
1899-1937	+180,100	-95	-22	-79	-17	..	..	+1,186	+1,142
1899-1909	+3,500	+1	-5	+7	-24	-55	..	+48	+47
1909-1919	+1,467	-52	+50	+14	+646	+181	..	+504	+468
1919-1929	+255	-84	-41	-69	-82	-44	..	+62	+64
1929-1937	-10	-29	-7	-45	-20	..	-11	-11	-9

^a Industries for which there are no adequate quantity data for any period listed above are aircraft and carriage and wagon materials. These industries are covered by the adjusted 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 the indexes

industries have been adjusted to take account of changes in the coverage of the respective samples, except when such adjustment was impossible.

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.

^c N.e.m. denotes not elsewhere made.

There were far-reaching changes in both the composition and the total of the automobile industry's output:

	1904	1909	1919	1923	1929	1937
	<i>Quantity (thousand units)</i>					
Passenger cars						
Open	19	117	1,400	2,215	444	20
Closed	a	5	157	1,202	3,917	3,826
Public conveyances			2	13	26	12
Trucks	0.4	3	120	281	386	602
All other types	2.6	2	209	190	520	172
All types	22	127	1,888	3,901	5,293	4,632
	<i>Percentage Distribution</i>					
Passenger cars						
Open	86	92	74	57	8	*
Closed	a	4	8	31	74	83
Public conveyances			*	*	1	*
Trucks	2	2	7	7	7	13
All other types	12	2	11	5	10	4
All types	100	100	100	100	100	100

* No data.

* Less than half of one percent.

In 1904 (the earliest year for which we have detailed data), open passenger cars accounted for nearly the entire output of the industry. This type of vehicle increased at a rapid rate until a peak was reached in 1923 with the production of more than 2,000,000. From then on open cars declined so rapidly that by 1937 only 20,000 were manufactured, about as many as in 1904. Virtually the entire history of the growth and decline of the product is compressed within the brief span of time covered in the tabulation just presented. Closed cars began to increase notably only in 1919, and even in 1923 their output was far below that of open cars. Within six years, however, they had largely displaced the latter, and by 1937 the process was just about completed. Public conveyances (taxicabs and busses) rose from 2,000 to 26,000 in the ten years between 1919 and 1929, and fell to 12,000 in 1937.

Chart 23

TRANSPORTATION EQUIPMENT

Indexes of Physical Output

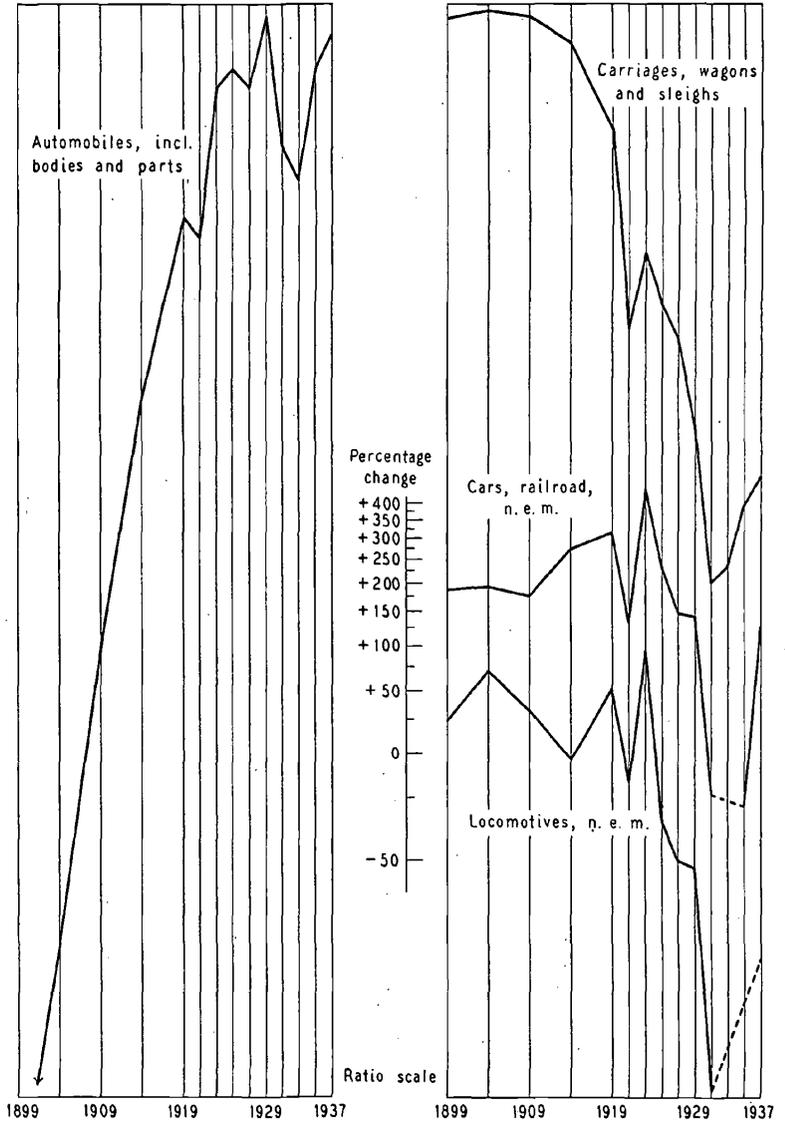
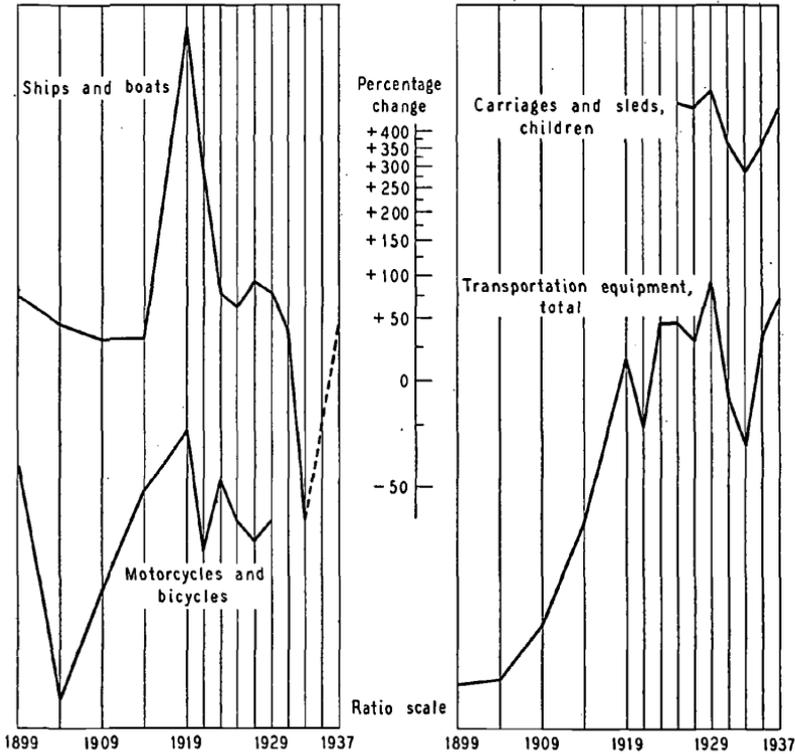


Chart 23 (concl.)

TRANSPORTATION EQUIPMENT

Indexes of Physical Output



The drop was attributable entirely to a decline in taxicabs, in miscellaneous public conveyances and in small busses. Larger busses (seating 21 or more passengers) rose from 3,400 in 1929 to 6,400 in 1937. Trucks, unlike passenger cars and all public conveyances, continued to increase rapidly even between 1929 and 1937.

Vast improvements in the quality of automobiles accompanied the rise in output. Even in the last decade, when output was declining, the quality changes continued. Below we

compare some of the specifications for the 1925 and the 1935 models of a leading make of passenger car: ²

<i>Description</i>	<i>1925</i>	<i>1935</i>	<i>Percentage Change</i>
Wheelbase, inches	100	112	+12
Horsepower, maximum developed	20	90	+350
Weight (two door sedan), pounds	1,900	2,700	+42
Piston displacement, cu. in.	177	221	+25
Front spring frequencies, o.p.m. ^a	160	85	-47
Acceleration, max. 10-25 m.p.h., ^c f.p.s. ^b	1.8	4.1	+128
Deceleration, max., f.p.s. ^b	12	21	+75
Speed, maximum, m.p.h. ^c	40	80	+100

^a Oscillations per minute under normal load.

^b Feet per second per second.

^c Miles per hour.

In addition to the improvements indicated by the tabulation, the 1935 car included as standard equipment anti-rattle devices, braces, dash gauges and meters, locks, shock absorbers, windshield wipers, safety glass, and a counterbalanced crankshaft. These had been available to car purchasers in 1925, but at extra cost. There were less obvious changes as well. Thus the development of instrumental control in the heat treatment of steel enhanced the quality of the steel used in the present-day motor car to a point only rarely approached on previous occasions.³

The output of finished automobiles measures only the gross output of the motor vehicles industry. The true net output of the industry must be related to the operations it performs on the materials it purchases and assembles into finished cars. A modification of the materials utilized may imply a change in the degree of fabrication within the in-

² A. T. Court, "Hedonic Price Indexes with Automotive Examples," *The Dynamics of Automobile Demand* (General Motors Corporation, 1939), p. 102. The make of the car is not given. The specifications are derived from a variety of unofficial sources. They are believed to be approximately correct.

³ G. Perazich, H. Schimmel and B. Rosenberg, *Industrial Instruments and Changing Technology*, Report No. M-1 (National Research Project, October 1938), pp. 54, 86.

dustry, and hence a change in net output, although gross output may remain unaltered. For example, the net output of an automobile plant which purchases readymade parts and merely assembles them, is less than the net output of a factory which manufactures and assembles the parts. And if a factory simply puts automobiles together with purchased parts in one year, and then subsequently takes to manufacturing the parts and assembling the automobiles, its net output will rise more than its gross output. There are strong indications that important changes of this sort have occurred. Until about 1900 the industry was in an experimental stage, and the automobile was a crude product of home or workshop. The manufacturer then had to make most of his own parts, since he could not secure them elsewhere.⁴ Shortly after the turn of the century the automobile industry passed the purely experimental stage. The manufacturers were able to purchase a substantial portion of the parts required, and many of them now merely assembled purchased parts.⁵ The 1905 Census states: "While some of the larger plants turn out all the parts, the smaller establishments, and by far the greater number, do not, but purchase more or less material in fully or partially manufactured form. In fact, there is a strong tendency in this direction. . . ." ⁶ In 1903, even the Ford enterprise was not much more than an assembly plant for parts purchased elsewhere, mainly from the Dodge Brothers' machine shop.⁷ The tendency to restrict activities to the assembly of parts became most pronounced in the period 1908-14 when "the cars of nearly all manufacturers were in large measure assembled, a few of even the leading makes almost entirely so." ⁸ About 1915 there were signs of a re-

⁴ R. C. Epstein, *The Automobile Industry, Its Economic and Commercial Development* (A. W. Shaw, 1928), p. 28.

⁵ *Ibid.*, p. 39.

⁶ 1905 Census, Part IV, p. 275.

⁷ L. H. Seltzer, *A Financial History of the American Automobile Industry* (Houghton Mifflin, 1928), p. 89.

⁸ Epstein, *op. cit.*, p. 51.

versal in tendency; the larger manufacturers now began to make their own parts, particularly engines. Among the numerous factors contributing to the change the most important were the need for certainty of supply for the sake of continuity of plant operation; the possibility of lower production costs; and the enhanced prestige and advertising advantage which was supposed to accrue from manufacture of the parts themselves.⁹ By 1918-20 the shift was almost complete, and most manufacturers were making the majority of the important parts.

About 1927, however, there was a revival of the old tendency to purchase outside parts because manufacturers began to put out a large variety of models.

The marketing advantages of a variety of models are opposed, however, to the manufacturing economies of standardized production. . . . One result of this antagonism promises to be a partial reversal, at least temporarily, of the tendency toward integration of manufacture: the delays and expense incident to frequent readjustment of integrated establishments for changes in models are likely to lead to increased reliance, once more, upon the more elastic organizations of the parts-makers.¹⁰

With the increase in the number of models produced it became more economical for a manufacturer to buy parts outside than to produce the large assortment needed within his plant. This factor, it should be noted, has always been of more importance in truck manufacture than in passenger car production.

Information on very recent tendencies is not available. Observers writing in 1932 remarked that automobile manufacturers were adopting machines which could be used for a wider range of cars than those they had previously employed. These writers noted, in addition, that there was an increasing

⁹ *Ibid.*, pp. 51-53.

¹⁰ Seltzer, *op. cit.*, p. 61.

tendency toward use of the same parts in different makes and models.¹¹ Both these developments may have presaged a return to more extensive parts manufacture by the automobile makers themselves.

The limited summary of changes in automobile production presented above touches upon only a few aspects of the relation between gross and net output in the Census industry, "automobiles, including bodies and parts." This relation is complicated further by the fact that so long as the parts plants are segregated, and their output is reported separately, the Census classifies them in such industries as engines, springs, stamped metal, etc., even though their products ultimately find their way into the automobile factory, and even if they are owned by the automobile manufacturers. Only the integration of a parts factory with an automobile assembly plant in a manner designed to make possible a single Census report can affect the Census industry with which we are here concerned; i.e., can cause a divergence between its gross and net output. This does seem to have occurred, according to the meager evidence relating to engines:¹²

<i>Year</i>	<i>Motor Vehicle Internal Combustion Carburetor Engines Made in the Engines In- dustry (1,000)</i>	<i>Motor Vehicles and Chassis Made in the Automobile Industry (1,000)</i>	<i>Percentage of Engines Made in the Engines Industry</i>	
1914	72	573	12.5	
1919	223	1,893	11.8	
1921	160	1,603	10.0	
1923	385	3,902	9.9	
1925	304	4,178	7.3	
1927	325	3,356	9.7	
1929	280	5,316	5.3	
1931	130	116	2,295	5.6
1933	33	1,848	1.8	
1935	69	3,923	1.8	
1937	105	4,733	2.2	

¹¹ Fraser and Doriot, *op. cit.*, pp. 45, 50.

¹² Changes in classification make necessary the overlapping series.

The percentage of engines made in the automobile industry rose from 87.5 in 1914 to 97.8 in 1937. These data indicate that the rise in the number of finished automobiles definitely understates the rise in the net physical output of the automobile industry, if all other factors remained constant.

Carriages, Wagons and Sleighs, in extreme contrast to the automobile industry, decreased in output almost continuously after 1904, the peak year in the Census series. From 1899 to 1937 the net decline was 95 percent. From 1899 to 1904 there was a slight increase, and from 1904 to 1909 a slight decline; in the next five years there was another drop, amounting to 15 percent. The decline became disastrous only in 1914, when the industry suffered from the competition of the large and rapidly-growing automobile industry. From 1914 to 1919 there was a decline of 42 percent, from 1919 to 1929 another drop, 84 percent, and from 1929 to 1937 still another decline, 29 percent. From 1899 to 1937 every product of the industry declined, although the decrease in farm wagons and trucks was least severe.

Locomotives, measured simply by the number of standard-gauge steam locomotives,¹³ decreased by 79 percent between 1899 and 1937. The trends in the series are overshadowed by violent cyclical movements, but it is clear that most, if not all, of the decline occurred in the second half of the long period. The Census peak year came in 1923, when 3,100 locomotives were produced. In 1937 the number was only 380.

Railroad Cars fell much less drastically, declining 22 percent from 1899 to 1937. In the first and fourth periods the changes were slight. In the second decade there was a rise of 50 percent, and in the third, a fall of 41 percent. The peak came, as in the case of locomotives, in 1923.¹⁴ Within the in-

¹³ No adjustment for coverage could be made for 1899-1923; the index therefore fluctuates more violently than it should.

¹⁴ The railroad car and locomotive industries suffer immense fluctuations in output which are associated primarily with business cycles. For this reason the figures in Table 62 portray inadequately the trends in output of cars

dustry there were increases in the output of cabooses, gondola cars and refrigerator cars. Passenger cars, flat cars, hopper cars and stock cars were subject to the most serious declines.

The output of both railroad equipment industries was greatly affected by quality improvements. As the accompanying figures indicate, the average tractive power of existing steam locomotives more than doubled in the 30 years from 1905 to 1935, and the average capacity of existing freight cars rose more than 50 percent. The corresponding rates of change in the power and capacity of *new* locomotives and freight cars were considerably lower. But even the higher

<i>Year</i>	Average Tractive Power, Steam Locomotives (thousand pounds)	Average Capacity, Freight Cars (tons)
1905	23.7	30.8
1910	27.3	35.9
1916	32.9	40.8
1920	36.4	42.4
1925	40.7	44.8
1930	45.2	46.6
1935	48.4	48.3

^a From data collected by the Interstate Commerce Commission, and published in the *Statistical Abstract, 1938*, p. 381, and *1931*, p. 415.

figures, when multiplied by the quantity indexes, indicate no rise between 1899 and 1937 in the aggregate tractive power of new locomotives built, and suggest only a moderate increase in the aggregate capacity of new freight cars.

Ships and Boats underwent extraordinarily violent changes in output. Over the 38 years there was a net decline of 17 percent. Between 1899 and 1909 the industry's output de-

and locomotives. From the available annual data, the trend in output of railroad cars and locomotives appears to have been upward only until 1907, and downward thereafter. The decline in car production between 1899 and 1909 and the rises in both series between 1909 and 1919 reflect the fact that 1909 was a depressed year in railroad equipment output.

clined 24 percent. From 1909 to 1914 output remained constant, then shot up at a tremendous rate to a peak in 1919, registering a gain of 650 percent.¹⁵ After 1919 there was a drastic fall, to a level somewhat above the pre-war output. Output in 1929 was approximately the same as it had been in 1923, but 1927 output was higher than that of either year. Finally, from 1929 to 1937 output fell 20 percent.

Steel ships grew in relation to wooden vessels. In 1899 the latter were most important (in terms of gross tonnage), but in 1909 and later years the production of steel ships exceeded that of the wooden ones. The fraction of output devoted to repair work fluctuated also. In 1899 the percentage (in terms of value) was 31; in 1909 it was 36; in 1919 it was 11; in 1929 it was 50; and in 1937 it was 38.¹⁶

Motorcycles and Bicycles also fluctuated in output. From 1899 to 1904 production fell sharply, then rose to a peak in 1919, when it stood 180 percent above the 1909 level and 27 percent above the 1899 level. From 1919 to 1929 output

¹⁵ The classification, ships and boats, does not cover government-owned shipyards. These shipyards did 29 million dollars worth of work in 1914, as compared with 90 million in private establishments; and 240 million dollars worth of work in 1919, as compared with 1,622 million in private yards. If we may judge from these figures, the combined output of private and government yards rose somewhat less rapidly from 1914 to 1919 than the output of private yards alone. No data on government-owned shipyards are available after 1919.

¹⁶ The index of physical output of the ships and boats industry is a rather rough measure, scarcely more satisfactory as a gauge of physical output than is value added. Several difficulties were involved in the construction of the index of physical output:

(1) The Census data on quantity of output relate to vessels launched, rather than to work done during the year, while the Census data on value of output relate to value of work done during the year, and not to value of vessels launched. For this reason no completely satisfactory weighting scheme can be devised. Further, the chronological reference of the quantity series is ambiguous. (2) The quantity data, which are given in terms of tonnage of vessels launched, are unsatisfactory measures of output because the tonnage unit is unstable, including as it does both gross tons and displacement tons; further, the relation between the two is neither fixed nor determinable. (3) The value of repair work done (for which there are no corresponding quantity data) constitutes a large and variable percentage of the total value of output. Our adjustment compensates only in part for this defect.

fell again, this time by 44 percent. For 1929 to 1937 the data on motorcycles are inadequate, so that no index is available for the recent period, but it is highly probable that total output rose as a result of a revival in the bicycle branch of the industry. The output of bicycles in 1937 was higher than in any preceding year.

Aircraft. Owing to changes in the Census schedules, the Census data on airplane production are inadequate. Moreover, there have been vast changes in the size and character of airplanes manufactured. We are therefore unable to present an index of physical output for the aircraft industry.¹⁷

The Group Total. The great diversity of trends within the group subjects any index of output for the group as a whole to considerable error, for slight changes in the weighting scheme used would have an important effect on the group index obtained. But while the index we present cannot be accepted as entirely accurate, there can scarcely be any doubt that its record of a mild rise in the first decade, a sharp increase in the second, a moderate gain in the third, and a decline in the fourth period, portrays the trend of the group as a whole. There is certainly no question that transportation equipment advanced more rapidly between 1899 and 1937 than most, if not all, other manufacturing groups.

Although, except for the petroleum and coal products

¹⁷ Data collected by the Bureau of Air Commerce of the Department of Commerce indicate that the following number of airplanes were produced in the United States from 1919 to 1937:

<i>Year</i>	<i>Number</i>	<i>Year</i>	<i>Number</i>
1919	660	1929	6,190
1921	300	1931	2,800
1923	590	1933	1,320
1925	790	1935	1,750
1927	1,990	1937	3,760

These include commercial planes, military planes, and planes for export, with average prices ranging in 1935 from \$3,700 for small single-engine airplanes to \$56,000 for multi-engine airplanes. Since the average size of planes has undoubtedly increased, the decline in number from 1929 to 1937 exaggerates the decline in the output of the aircraft industry.

group, the transportation equipment group made the largest net gain between 1899 and 1937, its output declined in the most recent period. Indeed, of the six component industries for which there are data, none achieved a net rise in output between 1929 and 1937.

TABLE 63

TRANSPORTATION EQUIPMENT

Relative Contributions of Component Industries to the Physical Output of the Entire Group^a

Industry	Percentage Distribution, Comparable Pairs of Years									
	1899	1937	1899	1909	1909	1919	1919	1929	1929	1937
Automobiles, incl. bodies and parts	0.4	89.7	1.6	38.1	23.1	62.9	41.0	88.5	82.2	81.7
Carriages, wagons and sleighs	19.3	0.1	30.6	21.2	16.7	1.4	2.1	0.2	0.4	0.3
Cars, railroad, n.e.m. ^b	19.4	1.8	21.0	13.6	21.1	5.5	8.8	3.1	4.9	5.1
Locomotives, n.e.m. ^b	19.5	0.5	7.7	5.6	11.0	2.2	4.4	0.8	2.0	1.2
Ships and boats ^c	25.1	2.5	24.3	12.6	19.9	25.9	41.2	4.6	7.4	6.6
Motorcycles and bicycles			6.9	2.2	1.8	0.9	1.2	0.4	d	d
Carriages and sleds, children's	16.3	5.5							0.6	0.5
All other products			7.9	6.7	6.4	1.2	1.2	2.4	2.4 ^d	4.5 ^d
TOTAL ^e	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

^a Derived from Table 62. For an explanation of the derivation of the measurements see footnote 10, Chapter 4.

^b N.e.m. denotes not elsewhere made.

^c Does not include government-owned shipyards.

^d Motorcycles and bicycles included in "All other products."

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

CHANGES IN THE INDUSTRIAL PATTERN OF TRANSPORTATION EQUIPMENT OUTPUT

Of the five industries in the transportation group for which we have complete data, only one, the automobile industry, advanced in output between 1899 and 1937. This advance proceeded at an astonishingly rapid rate, effecting an enormous change in the composition of the group's output, as Table 63 shows.

In 1899 the two railroad equipment industries accounted for 43 percent of the group's output, ships and boats for 27 percent, and carriages, wagons and sleighs for 21 percent. All other industries made up the balance of 9 percent. In that year automobiles contributed less than 1 percent to the

TABLE 64

TRANSPORTATION EQUIPMENT

Relative Contributions of Component Industries to the Value Added by the Entire Group^a

Industry	Percentage Distribution				
	1899	1909	1919	1929	1937
Aircraft	} 8.4	1.8 {	0.3	1.8	3.7
Motorcycles and bicycles			1.1	0.5	0.9
Automobile bodies and parts	0.0	10.0	13.6	29.1	42.4
Automobiles	1.6	27.4	33.4	55.6	36.9
Carriage and wagon materials	6.7	5.3	0.5	0.1	^b
Carriages and sleds, children's	1.3	1.5	0.5	0.6	0.5
Carriages, wagons and sleighs	33.2	19.9	1.6	0.3	0.2
Cars, railroad, n.e.m. ^c	17.8	15.4	7.8	4.4	5.7
Locomotives, n.e.m. ^c	8.3	5.3	3.5	1.3	1.7
Ships and boats ^d	22.8	13.4	37.7	6.2	7.9
TOTAL ^e	100.0	100.0	100.0	100.0	100.0

^a Basic data are given in Appendix C.

^b Abandoned as a separate classification in 1931. Included in carriages, wagons, and sleighs; and in wood turned and shaped.

^c N.e.m. denotes not elsewhere made.

^d Does not include government-owned shipyards.

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

group's output. In 1937 the picture was altogether different. The group was now dominated by a single industry, since automobiles accounted for 92 percent of its output.

Data on the industrial pattern of value added in the transportation equipment group add little to the picture presented in Table 63. Thus Table 64 records the comparative rise of the aircraft industry and the decline of the carriage and wagon industry. The distinction between automobiles and bodies and parts is of doubtful value, since the line of separation between the two industries is continually shifting.¹⁸

¹⁸ According to a preliminary statement, the Bureau of the Census has abandoned the distinction between these two industries, and in the 1939 Census report they will be combined.