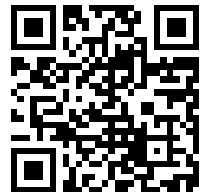

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THE AUTOMOBILE INDUSTRY AND ITS FUTURE

BY

LEONARD P. AYRES

VICE-PRESIDENT, THE CLEVELAND TRUST COMPANY

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THE AUTOMOBILE INDUSTRY AND ITS FUTURE

Until recently the use of automobiles was forbidden on the island of Nantucket. If we can imagine the prohibition against importing cars to the island being continued, but their local manufacture permitted, we may be able to work out, with the small figures involved, some of the principles that are applicable to the statistics of automobiles in this country.

Let us suppose that a local manufacturer on the island should begin to build cars, constructing five during the first year, six the second year, seven the third, and so on until he reached a steady output of 10 cars per annum, at which rate he continued indefinitely. Let us also suppose that each car lasted long enough to be registered for six years in succession. Under these conditions the statistical history of the industry on the island would be told by the figures of Table 1. The table should be read across, line by line, so as to follow the different stages in the development of the situation year by year, instead of being read up and down in the columns.

A careful study of Table 1 reveals some important principles that will be useful in the interpretation of actual figures for the industry. The first of these is that the figures for registration are always larger than the actual number of cars in use even when the data are entirely accurate.

Registration consists of the new cars put into use during the year, plus the old ones carried over from last year. It begins at nothing in January and increases all the time up to the end of December. During these 12 months cars are being destroyed in collisions, burned, or otherwise wrecked, and scrapped or sold for junk, but each one of them that is run at all has been registered. All through the year the number in use is lower

than the total registration and by the end of the year it is much lower.

A second important principle is that, under the conditions assumed, the number of cars registered in any of the later years of the period is always equal to the number made in that year plus those produced in the five previous years. In this case the assumption was made that each car lasted for six registrations and the table shows that the total registration in any year is equal to the total production of the six years ending with that one. In a similar way the average life of cars in general may be ascertained if accurate data for production and registration are available.

TABLE 1.—PRODUCTION, REGISTRATION, AND ELIMINATION OF AUTOMOBILES WHERE THE OUTPUT IS AS SHOWN AND EACH CAR LASTS LONG ENOUGH TO BE REGISTERED FOR SIX SUCCESSIVE SEASONS

Year	Carried over from last year	New cars made	Registration during year	Cars eliminated during year	Cars in use at end of year
First	..	5	5	..	5
Second	5	6	11	..	11
Third	11	7	18	..	18
Fourth	18	8	26	..	26
Fifth	26	9	35	..	35
Sixth	35	10	45	5	40
Seventh	40	10	50	6	44
Eighth	44	10	54	7	47
Ninth	47	10	57	8	49
Tenth	49	10	59	9	50
Eleventh	50	10	60	10	50
Twelfth	50	10	60	10	50

A third noteworthy fact is that if reliable figures for production and registration can be secured all the other columns of such a table as we have here can be filled in. For example, in Table 1 the figures show that 50 cars were registered in the seventh year. Ten of these were new cars, so 40 of them were carried over from the previous year. But in that year 45 cars were registered and, since only 40 were carried over, five must have been eliminated during the sixth year as the table shows.

By following through this sort of process each column of the table may be supplied with its appropriate figures if only we have the data for production and registration.

Fortunately, fairly reliable figures of these two sorts are available for a number of years past and by using them carefully a table like the one we have been discussing may be constructed for the whole country.

REGISTRATION

Fairly reliable figures for the registration of automobiles in each state are available beginning with the year 1912. They have been compiled from year to year by Automotive Industries, the Office of Public Roads and Rural Engineering in the Department of Agriculture, and other agencies. These figures are not entirely complete, nor are they gathered on a uniform basis in each state. In a number of states, such as Indiana, Nebraska, Tennessee, and Utah, the records do not run back to 1912. In Texas the registration has been by counties. In some states, such as Tennessee and Minnesota, it has not been by annual periods.

The figures of Table 2 on page 6 are the results of a careful attempt to construct a complete record of registration for each state since 1912. Where figures have been missing in the original records they have been supplied by using data based on those of neighboring states. Similar methods have been used where the data were based on three-year registrations, or perennial systems. The figures are in round thousands because it is believed that greater detail would not increase their reliability. As the table stands it is believed to represent, somewhat more accurately than have previous compilations, the number of motor cars that would have been registered in each state each year if the system of registration had been complete and uniform since 1912. The data include both passenger and commercial cars, but not motor cycles, tractors, or dealers' cars.

TABLE 2.—THOUSANDS OF MOTOR CARS REGISTERED IN EACH STATE AND IN THE GEOGRAPHIC DIVISIONS EACH YEAR FROM 1912 TO 1920

	1912	1913	1914	1915	1916	1917	1918	1919	1920
Maine	8	11	16	22	31	41	40	53	63
New Hampshire	6	7	10	13	18	22	25	32	35
Vermont	4	6	8	11	16	20	22	27	32
Massachusetts	50	63	77	103	137	174	193	247	305
Rhode Island	9	10	12	16	21	37	36	45	50
Connecticut	24	27	33	44	62	86	93	110	119
New England	101	124	156	209	285	380	409	514	604
New York	107	134	170	234	318	412	464	572	669
New Jersey	43	49	60	78	104	135	156	191	228
Pennsylvania	59	76	113	160	231	325	394	482	570
Middle Atlantic	209	259	343	472	653	872	1,014	1,245	1,467
Ohio	63	86	123	181	252	347	413	511	615
Indiana	34	47	66	97	139	192	227	277	333
Illinois	68	95	131	181	248	340	390	478	569
Michigan	40	54	76	115	160	247	262	326	413
Wisconsin	25	35	53	80	116	166	197	237	293
East No. Central	230	317	449	654	915	1,292	1,489	1,829	2,223
Minnesota	29	38	68	93	138	163	165	195	224
Iowa	47	75	112	152	199	254	278	364	437
Missouri	24	38	54	76	104	148	188	244	297
North Dakota	9	13	16	25	40	63	72	83	91
South Dakota	14	15	21	29	44	67	91	105	120
Nebraska	16	26	41	59	101	148	175	192	223
Kansas	22	34	49	73	112	159	189	228	265
West No. Central	161	239	361	507	738	1,002	1,158	1,411	1,657
Delaware	2	2	3	5	7	11	13	16	18
Maryland	10	14	20	31	44	61	75	96	112
Dist. of Columbia	2	2	5	8	13	15	30	35	40
Virginia	6	9	14	21	35	55	72	94	134
West Virginia	5	5	6	13	21	31	39	50	79
North Carolina	6	10	15	21	34	56	72	109	141
South Carolina	10	12	15	15	19	40	55	70	93
Georgia	19	19	21	26	48	70	100	127	144
Florida	2	2	3	11	21	27	54	55	74
So. Atlantic	62	75	102	151	242	366	510	652	835
Kentucky	5	7	12	20	32	47	66	91	113
Tennessee	9	12	20	25	30	48	63	80	102
Alabama	3	5	8	12	22	33	46	59	75
Mississippi	3	3	6	10	25	37	48	55	63
East So. Central	20	27	46	67	109	165	223	285	353
Arkansas	2	3	6	8	15	29	41	49	59
Louisiana	7	7	12	11	17	28	40	51	66
Oklahoma	7	8	14	25	53	100	122	145	204
Texas	35	54	65	138	198	213	251	331	428
West So. Central	51	72	97	182	283	370	454	576	757
Montana	2	6	10	14	24	43	51	59	61
Idaho	2	2	3	7	13	25	32	42	51
Wyoming	1	2	2	4	7	13	16	21	24
Colorado	9	13	18	28	43	67	84	105	129
New Mexico	1	2	3	5	8	8	15	18	22
Arizona	2	3	5	7	12	20	24	29	35
Utah	3	4	7	9	14	24	32	35	43
Nevada	1	1	1	2	5	7	8	9	10
Mountain	21	33	49	76	126	207	262	318	375
Washington	14	24	30	39	61	91	117	149	174
Oregon	10	14	16	24	34	49	63	83	104
California	65	103	124	164	232	307	365	477	569
Pacific	89	141	170	227	327	447	545	709	847
United States	944	1,287	1,773	2,545	3,678	5,101	6,064	7,539	9,118

PRODUCTION

The year 1895 may be taken somewhat arbitrarily as marking the beginning of the automobile industry on a commercial basis in America. It seems probable that the first electric vehicle for street use was sold by William Morrison of Des Moines, Iowa, in 1892. The first sale of a gasoline propelled car was made by Alexander Winton of Cleveland, Ohio, in 1898. During 1896, 1897, and 1898 at least ten of the important pioneer companies began the sale of electric cars, while several makers of gasoline and steam cars began manufacturing in 1899 and 1900.

The first official data on car output are those of the Census of Manufacturers of 1899. By that date so great progress had been made that the census recorded 57 establishments, employing 2,241 wage earners, as making automobiles. Their output during the year was 3,700 vehicles, and in addition 174 more were made in factories primarily devoted to the manufacture of carriages and wagons. This output of 3,874 cars in 1899 undoubtedly consisted mostly of electric vehicles.

Table 3 on page 8 is the fundamental table of this report. It attempts to give the essential data with regard to the production and use of automobiles since the beginning of the industry in this country. Its production figures have been taken from the reports of the census each five years beginning with 1899, supplemented by data for the intervening years compiled by the National Automobile Chamber of Commerce. In addition the War Industries Board reported official figures for the years 1917 and 1918. The figures of Table 3 prior to 1899, and from that date on to the next official data in 1904, are estimates.

EXPORTS AND IMPORTS

Table 3 gives in its second column the computed number of old cars carried over each year from the year previous. It gives in the next two columns the number of Ford cars and of other cars built each year. This distinction is made because it is of fundamental importance in a consideration of the past history and probable future of the industry. The fourth and

TABLE 3.—PRODUCTION AND USE OF AUTOMOBILES IN THE UNITED STATES SINCE THE BEGINNING OF THE INDUSTRY. FUNDAMENTAL TABLE

Year	Cars carried over from last year	Ford cars made	Other cars made	Cars imported	Cars exported	Total new cars added during year	Cars registered during year	Cars eliminated during year	Cars in use at end of year
1895	..	..	300	..	..	300	300	..	300
1896	300	..	600	..	..	600	900	..	900
1897	900	..	1,200	..	..	1,200	2,100	..	2,100
1898	2,100	..	2,400	100	..	2,500	4,600	..	4,600
1899	4,600	..	3,874	150	..	4,024	8,624	..	8,624
1900	8,624	..	5,000	200	..	5,200	13,824	300	13,524
1901	13,524	..	7,000	250	184	7,066	20,590	600	19,990
1902	19,990	..	9,000	300	535	8,765	28,755	1,200	27,555
1903	27,555	708	10,292	350	822	10,528	38,083	2,500	35,583
1904	35,583	1,000	21,830	400	949	22,281	57,864	4,024	53,840
1905	53,840	1,695	23,305	496	1,348	24,148	77,988	5,200	72,788
1906	72,788	1,599	32,401	1,295	1,155	34,140	106,928	7,066	99,862
1907	99,862	8,423	35,577	1,093	2,894	42,199	142,031	8,765	133,296
1908	133,296	6,398	58,602	1,347	2,164	64,183	197,479	10,528	186,951
1909	186,951	10,607	116,680	1,645	4,686	124,246	311,197	22,281	288,916
1910	288,916	18,664	168,336	1,024	8,443	179,581	468,497	24,148	444,349
1911	444,349	34,528	175,472	972	15,807	195,165	639,514	50,662	588,852
1912	588,852	78,440	299,560	868	23,720	355,148	944,000	115,603	828,397
1913	828,397	168,220	316,780	492	26,889	458,603	1,287,000	61,570	1,225,430
1914	1,225,430	248,307	324,732	296	25,765	547,570	1,773,000	56,881	1,716,119
1915	1,716,119	308,213	584,405	221	63,958	828,881	2,545,000	371,196	2,173,804
1916	2,173,804	523,929	1,059,688	1,429	80,850	1,504,196	3,678,000	365,790	3,312,210
1917	3,312,210	735,256	1,133,691	78	80,235	1,788,790	5,101,000	81,219	5,019,781
1918	5,019,781	706,584	447,053	73	109,491	1,044,219	6,064,000	319,009	5,744,991
1919	5,744,991	790,954	1,085,402	117	82,464	1,794,009	7,539,000	446,010	7,092,990
1920	7,092,990	1,027,677	1,177,520	926	180,287	2,025,836	9,118,000	..	..

fifth columns give the number of cars imported and exported each year. These data are taken mainly from the reports of the Bureau of Foreign and Domestic Commerce of the Department of Commerce and from the earlier summaries of Commerce and Finance that preceded them. The very earliest figures of the columns are partly estimated. The exports for 1918 have been increased to include the cars shipped abroad by the Army.

NEW CARS ADDED EACH YEAR

The sixth column gives the total number of new cars added each year. The figures are the result of adding the new Fords and the other cars manufactured and the cars imported, and then subtracting from this total the cars exported. The results probably give with fairly close accuracy the total number of cars that have been put into use in this country since the inception of the industry 25 years ago. Up to the end of 1920 the total number of cars made in the United States has been 11,775,163 according to these figures. Of this number 4,671,202 were Ford cars. The aggregate imports have been 13,296 and the exports 712,646.

After making allowance for imports and exports it is found that the total number of new cars put into use in this country since the beginning has been 11,075,813. Since the number registered last year was somewhat in excess of 9,000,000, and the number in use at the end of the year undoubtedly rather less than that number, it follows that about 2,000,000 cars have been eliminated and it is one of the purposes of this report to find how these eliminations have been distributed.

COMPUTATION OF REGISTRATION

The third column from the last gives the number of cars registered each year. These are figures of record beginning with 1912. Previous to that date they are computed by calling the registration of any one year equal to the number of cars put into use in that year and the five previous years. This method applied to the last nine years of the series for which we have

actual data of record gives closely accurate results and so its use for the earlier years seems justifiable. It gives us figures showing how many cars would have been registered each year if the system of annual registrations had been continuously in use, and these figures may be accepted as being fairly reliable estimates.

COMPUTATION OF ELIMINATION

In the next to the last column are figures showing the number of cars eliminated each year. As has already been explained, these data may always be found if the figures for new cars made and cars registered are available over a series of years. Registration can only consist of two kinds of cars—new ones made during the year, and old ones carried over from the previous year. Since this is true, the carry-over can always be found by subtracting the new cars from the total registration. But the registration of the previous year consisted of these same cars that survived to the end of December and went on in use in January, plus certain others that were eliminated and so did not go on. Their number may be ascertained by subtraction.

All this may be made even clearer by noting that the cars registered in 1920 were more than 9,000,000. Since about 2,000,000 were new cars made in that year, the carry-over from 1919 was about 7,000,000. But the registration in 1919 was about 7,500,000, so the elimination in that year was in the neighborhood of 500,000. The actual figure given is 446,010. This method of computing elimination has not been used in previous studies, so far as the author knows, but it is believed that careful consideration will show that it is valid.

Certain doubts as to the reliability of the figures of Table 3 should be noted, but it is believed that they do not relate to the principles on which the work has been based. They relate rather to the completeness and accuracy of the figures for production and registration, and to the assumptions that practically all cars made are registered in the year in which they are produced, and that comparatively few cars escape registration or have duplicate registrations. The questions involved

in all these possibilities suggest sources of error. These are at present unavoidable and they modify but do not at all destroy the value of the figures used.

THE DATA OF ELIMINATION

It will be noted that in the column of Table 3, giving the data for elimination, the numbers previous to 1911 are in each case equal to the figures for new cars added five years earlier. This is because the registration figures for this early period are not data of record but are computed as being equal to six years of production after corrections are made for exports and imports. Because this method is followed in this early period, and both the eliminations and registrations are inferred from the known data of production, the figures for cars dropped from use are always equal to those showing the number newly put into use five years earlier.

Beginning in 1911 all this is changed. From this point on the data for elimination are based on the recorded figures for production and registration. This gives us an opportunity to compare the two methods and to find how nearly the number of cars eliminated each year since 1911 compares with the number of new cars added in the fifth previous year. The comparison is given in Table 4 and it shows that the annual elimination is sometimes smaller and in other years larger than the new cars added five years earlier, but that the two methods tend to give about the same results in the long run.

It seems probable that the discrepancies between the two sets of figures are due in large measure to inaccuracies in the data for production and registration. It is certain that such inaccuracies exist and in fairly serious amount. One recent bit of evidence on this point is to be found in the difference between the figures for production in 1919 as compiled by the National Automobile Chamber of Commerce, which amounted to 1,974,016 cars, and those just issued by the Census of Manufactures which showed only 1,876,356, or nearly 100,000 fewer cars made in that year.

TABLE 4.—CARS ELIMINATED EACH YEAR COMPARED WITH NEW CARS ADDED FIVE YEARS EARLIER

Year	Cars eliminated during year	New cars added five years earlier	Cars eliminated beginning with 1911	New cars added beginning with 1906
1911	50,662	34,140	50,662	34,140
1912	115,603	42,199	166,265	76,339
1913	61,570	64,183	227,835	140,522
1914	56,881	124,246	284,716	264,760
1915	371,196	179,581	655,912	444,349
1916	365,790	195,165	1,021,702	639,514
1917	81,219	355,148	1,102,921	994,662
1918	319,009	458,603	1,421,930	1,453,265
1919	446,010	547,570	1,867,940	2,000,835

One figure of Table 4 which is noteworthy is the one showing 319,009 cars eliminated in 1918, which was the war year, during which production was restricted. It might reasonably be assumed that elimination during that year would have been much lower than this, for many people used cars that under other conditions would have been discarded. The real explanation is probably to be found in the fact that figures for elimination represent the cars that were used during the year for the last time. They were registered and ran that year but were discarded as soon as it was possible to replace them by new cars after the close of the war. Viewed in this light it becomes entirely reasonable that the elimination figures for 1918 should be high. In general the figures for cars discarded show a tendency to be high in years of prosperity and low in years of business depression.

AVERAGE LENGTH OF SERVICE

The most dependable method for computing the average life, or duration of service, of automobiles seems to be that which compares the registration of any year with the figures for production of that and previous years. The cars actually in use in any year must consist of those produced during that year, plus most of those produced the year before, plus a large part of those produced the year before that, and so on until some

year is reached so far back that no survivors of its production are still running.

Now it is true that some cars are destroyed almost as soon as they are put into service, while others that were first registered 10 years ago or more are still running, but the outstanding fact about the registration figures is that they have been for the past nine years about equal each year to the sum of the cars produced in that year and the five previous years. This means that the average length of life of the cars has been about six registrations, for if it had been only five registrations or as much as seven registrations, the figures for all cars registered each year would have been about equal to the new cars put into service over a five-year period, or a seven-year period, as the case might be. The fact that some individual cars have much longer or shorter terms of use does not alter the inference about the average term of use.

There is available some additional evidence tending to substantiate the proposition that the average length of service of automobiles is about six registrations, which is equal to something more than five full years. For example, the report of the Postmaster General for 1916 indicates that the depreciation of cars in the postal service has been at the average rate of 22.9 per cent per year. The annual reports of the statistics of express companies, published by the Interstate Commerce Commission, show substantially the same depreciation. These cars receive exceptionally hard usage.

Table 5 and Diagram 1 illustrate the way in which the annual figures for registrations for each year beginning with 1912 compare with the figures showing the number of new cars put into use in that year and the five preceding years. In the diagram there are two upright columns for each year. The right hand column of each pair, in solid black, represents the registration for that year, while the left hand column, in outline, is proportional to the new cars put into service in each six-year period. These columns are in each case divided into six sections, representing the new cars of the six years involved,

TABLE 5.—CARS REGISTERED EACH YEAR COMPARED WITH SUM OF NEW CARS ADDED IN THAT YEAR AND FIVE PRECEDING YEARS. NUMBERS IN THOUSANDS

Year	Cars registered during year	New cars added during six-year period	Per cent. that six-year additions are of registrations
1912	944	961	102
1913	1,287	1,377	107
1914	1,773	1,860	105
1915	2,545	2,565	101
1916	3,678	3,890	106
1917	5,101	5,483	108
1918	6,064	6,172	102
1919	7,539	7,508	100
1920	9,118	8,985	99

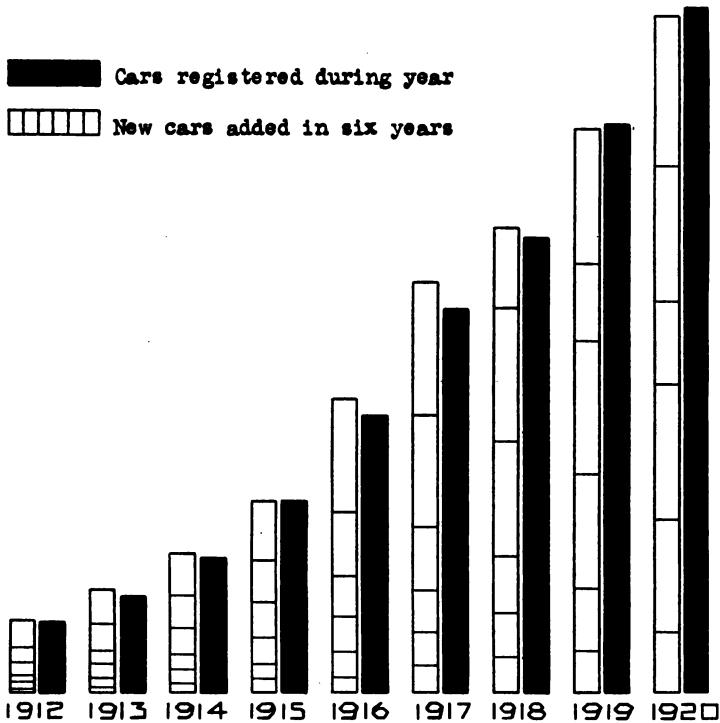


Diagram 1.—Cars registered each year compared with new cars added in that year and five preceding years

with those of the earliest year represented by the portion at the bottom of the column, and those of each later year in order above it. It will be noted that there is close agreement between the heights of the two columns in each case.

It is somewhat surprising to note from the evidence of the table and diagram that the average length of service of the cars appears to have stayed nearly constant toward the end of the period covered, instead of growing longer as cars and roads have been improved. It seems not improbable that this has actually happened but not because of any decline in the quality of the cars. In recent years the great increase in output and registration of automobiles has been largely caused by the enormous production of light and inexpensive cars and a major part of them have gone into farming communities where they have been subjected to the hardest sort of use over the worst kind of roads. It is probably true that this has held down the average length of service of all cars in the last few years and that it will continue to do so even if the more expensive cars of high-grade construction last much longer than an average of six seasons.

PEOPLE PER CAR

The number of persons in the entire population for each car in use each year is shown in Table 6, which gives the information according to the same geographical groupings of states as were used in Table 2. It is to be noted that these are not based on data for registration but rather on the computed numbers of cars in use at the end of each year. This gives a more accurate estimate of the extent of use of automobiles than do the computations based on registration figures which have been much used in discussions of this sort.

The figures of Table 6 impressively illustrate the great rapidity with which the automobile has been adopted by the American people. So short a time ago as in 1912 there were 114 people for each car in use, while eight years later there was one car for each 12 people. The table shows also the great differences that exist between the several divisions of the country with

respect to the use of motor cars. The extremes are found in the states of the Pacific division with one car for every seven persons and those of the East South Central division with only one car for each 27 people.

TABLE 6.—PEOPLE PER CAR IN USE EACH YEAR

Division	1912	1913	1914	1915	1916	1917	1918	1919	1920
New England	76	58	46	39	28	19	19	15	13
Middle Atlantic	109	82	62	52	36	25	23	19	16
East No. Central	94	64	45	36	25	16	15	12	10
West No. Central	84	52	34	28	18	12	11	9	8
South Atlantic	232	179	130	102	61	37	28	23	18
East So. Central	473	329	191	152	89	54	42	33	27
West So. Central	202	134	100	61	38	27	23	19	14
Mountain	154	92	62	46	27	15	13	11	10
Pacific	57	34	29	25	17	12	10	8	7
United States	114	78	57	46	30	20	18	15	12

Such figures as these inevitably bring to mind the question of the limits to the ability of the country to purchase and use cars. Estimates regarding this limit of using capacity of the country have varied enormously. On the one hand it may be pointed out that there are already states, such as South Dakota, Iowa, Nebraska, Kansas, and California, so well supplied with automobiles that the entire population could probably go riding simultaneously. On the other hand, it may be argued that with only about 8,500,000 motor vehicles in use in a country of more than 105,000,000 people, great possible markets still exist.

This last suggestion is worthy of more detailed consideration and perhaps the most enlightening way to approach it is through studying the composition of the population with reference to its probable purchasing power for automobiles. Unfortunately the census data for 1920 are not yet available, but those of 1910 give us a fairly reliable basis for discovering the proportions of the whole population found in certain great groups.

In Table 7 will be found figures showing the percentage of the population found at the previous census period in each of three age groups and five nativity groups.

TABLE 7.—PERCENTAGE OF THE ENTIRE POPULATION IN 1910 IN CERTAIN AGE AND NATIVITY GROUPS

Group	Under 21 years of age	From 21 to 65 years of age	Over 65 years of age	Total
Native-born white males	18	18	1	37
Native-born white females	18	17	1	36
Foreign-born white males	1	7	1	9
Foreign-born white females	1	5	1	7
Colored	6	5	..	11
Total	44	52	4	100

The table shows that great deductions must be made from the total population of the country as soon as we begin the attempt to estimate the possible purchasers of automobiles. To begin with, some 44 out of each 100 are less than 21 years of age, while 4 in each 100 are over 65 years of age. This leaves 52 per cent of the people from among whom most of the purchasers must clearly come. Of this 52 there are 17 who are immigrants and colored people. While there are in the aggregate many motor owners in these groups, it seems entirely probable that no very large number among them who do not already own cars will be able to purchase them during the next few years.

The remaining possible purchasers are the 35 per cent consisting of the native-born white men and women of between the ages of 21 and 65. About half of them are women who are in the main the wives of the men. It seems to be a fair conclusion from our figures that the purchasers of automobiles will in their very great majority come from the 18 per cent of the population who are native white men between the ages of 21 and 65. Since the population consists of some 105,000,000 people, this group comprises about 19,000,000. Probably about half of them already own cars. This would seem to be a

safe conclusion, even after allowance has been made for the ownership of more than one car by one individual and the ownership of trucks and passenger cars by corporations.

Computations have been made to discover the number of cars in use each year in each division of the country for every 100 native white men above the age of 21, for it is believed that this is a safer basis for estimating possible future domestic markets than most of the others that have been used. These computations are based on the data that have already been reviewed except that all native white men over 21 have been included, instead of only those between the ages of 21 and 65. The group used includes all native white men of voting age and the approximate number of them in each geographical division has been computed for each year. The results are presented in Table 8.

TABLE 8.—CARS IN USE EACH YEAR FOR EACH 100 NATIVE WHITE MEN OF VOTING AGE

Division	1912	1913	1914	1915	1916	1917	1918	1919	1920
New England	7	9	12	14	20	29	29	36	42
North Atlantic	5	7	9	11	15	22	25	29	34
East North Central	5	7	10	13	19	29	32	38	45
West North Central	5	9	13	16	25	37	41	49	57
South Atlantic	3	3	5	6	10	17	22	28	35
East South Central	1	2	3	4	7	11	14	18	22
West South Central	3	4	6	9	15	21	24	30	39
Mountain	3	5	7	9	16	28	33	39	45
Pacific	7	12	15	16	24	36	41	51	60
United States	5	7	9	11	17	26	29	35	42

There are two important facts revealed by the figures of Table 8. The first of these is that the number of potential purchasers in this country who are still unsupplied with cars is much smaller than has generally been supposed. This interpretation of the data is based on the assumption that the number of potential purchasers is best measured by ascertaining the number of native-born white men who constitute a very large part of the earning and spending capacity of the country.

The second significant fact is that the use of this criterion for computing the probable limits of the domestic market gives results that vary much less between the different sections of the country than do the figures based on the relationship between the number of people and the cars in use. This feature of the data may be readily noted if the two sets of figures are reduced to comparable terms and put in parallel columns. In Table 6 figures have already been presented showing the number of people in the population for each car in use. Since the number of native-born white men is not far from one-fifth of the population, we may now find how many of these men there were in 1920 for each five cars in use and compare the two sets of results. This is done in Table 9.

TABLE 9.—PEOPLE PER CAR AND ADULT, NATIVE-BORN, WHITE MEN PER FIVE CARS IN USE IN 1920, BY DIVISIONS

Division	People per car in use	White, native-born men for each five cars in use
New England	13	12
Middle Atlantic	16	15
East No. Central	10	11
West No. Central	8	9
South Atlantic	18	14
East So. Central	27	22
West So. Central	14	13
Mountain	10	11
Pacific	7	8
United States	12	12

The differences between the two sets of figures are largely due to the high proportions of white, native-born men in our Western states and the large numbers of children and colored people in the Southern ones. The figures in the last column of the table indicate that the market for cars in the Western states has not been so fully supplied as previous figures have indicated, while that in the Southern states is more fully met than has been thought.

THE NUMBER OF FAMILIES

The previous sections have suggested that the number of motor vehicles that this country could purchase and use could hardly exceed as a limit about 20,000,000 because that was approximately the number of native-born white men. This number is also about equal to the number of native white families. At the census of 1910 there were on the average 4.5 people to a family and a total of some 20,000,000 families. The same ratio in 1920 would give a total of about 23,510,000 families, of which about 20,000,000 would be whites.

WAGE EARNERS

The number of persons in gainful occupations in 1910 was recorded as being over 38,000,000, of whom about 30,000,000 were men and boys. This number includes many young people, for the entire male population above the age of 10 was 37,000,000, and of these 30,000,000 were recorded as being money earners.

While many changes have taken place since 1910 in the distribution of people in the occupations, it is probable that the changes in the proportions in each sort of work have not been so revolutionary as to make a study of the earlier figures misleading. Accordingly the writer has gone through the data of the occupational census of 1910 and taken out of the lists of the gainfully employed all those engaged in such sorts of work as to make it improbable that they would be included among the purchasers of automobiles. Those subtracted from the number of men gainfully employed are the following:

common laborers	lumbermen
semi-skilled workers	soldiers
apprentices and boys	sailors
clerks	domestic and personal workers
stenographers	life savers
fishermen	lighthouse keepers

These subtractions reduce the number of men wage earners in 1910 from 30,091,564 to only 16,865,546, and if this number is increased in proportion to the population, so as to make it

applicable to the census figures for 1920, it becomes 19,384,584. Similar reductions in the case of women workers bring their number down to a comparatively low point, but the changes in the occupations of women have been so considerable since 1910 that it seems best to omit them from the present calculations.

THREE SETS OF EVIDENCE

We have reviewed three bodies of evidence which tend to indicate that the class of people in this country, among which many purchasers of automobiles may be found, numbers about 20,000,000 persons. This is approximately the number of white, native-born men. It is also about the number of white families. It is also about the number of persons earning money who are in occupations that may be sufficiently remunerative and of such a nature that they are not disbarred from becoming purchasers of automobiles. All three bodies of evidence are in substantial agreement.

THE SATURATION POINT

The writer believes that the available evidence is inadequate to permit making at this time a valuable estimate of the probable saturation point of the automobile industry. It seems to him clear that nearly every family would like to own a passenger automobile, that many individuals would like to own cars in addition to the family machines, and that there are few commercial and industrial establishments that would not possess commercial cars or trucks if they could.

It seems equally clear that no such universal use of automobiles is possible at present or in the near future because a large proportion of the people can not afford to purchase or run them. The only competent estimates of the distribution of incomes in the United States are those for 1910 compiled by Willard I. King, in his volume entitled "The Wealth and Income of the People of the United States." Those figures are now seriously out of date and do not represent present conditions. Within a few months a new series of carefully compiled

estimates will be published by the National Bureau of Economic Research in New York City, but these results are unfortunately not yet available.

The results of Professor King's researches are presented in Diagram 2. They show for 1910 how many families in each typical 1,000 received each amount of annual income. They show that at that time more than two-thirds of the families

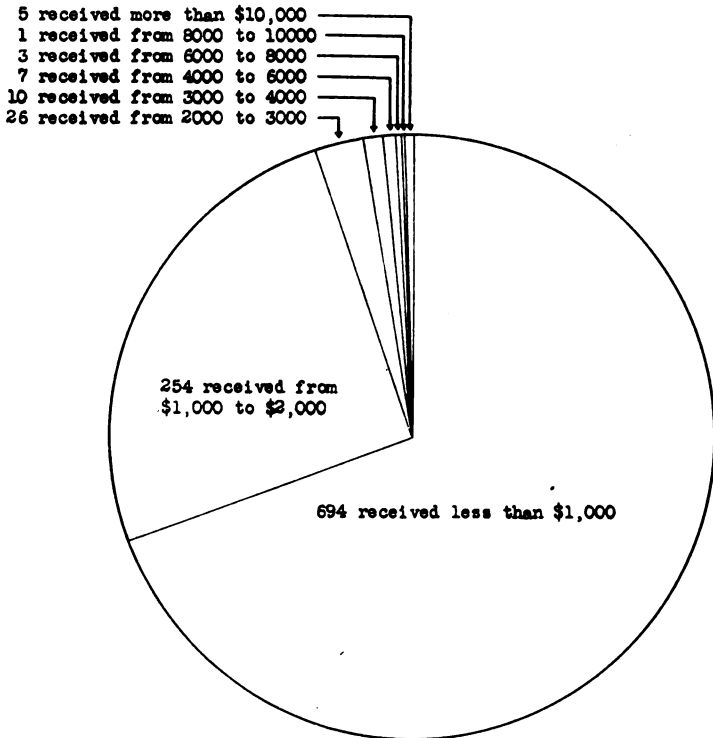


Diagram 2.—Incomes received in 1910 by each 1,000 families

were receiving annual incomes of less than \$1,000 and that some 95 per cent of all received less than \$2,000 a year. The new estimates will show marked increases over these income figures, but the general lesson of the diagram will remain unchanged.

The new figures, like the old ones, will show that many more than half of all the income receivers get less than \$1,000 a year

and this is true even after careful allowance has been made for the value of the produce of farmers that is consumed by themselves and their families without being sold.

The value of these figures in estimating the possibility of increased markets for automobiles is great. They indicate that increases in the domestic markets must be largely among

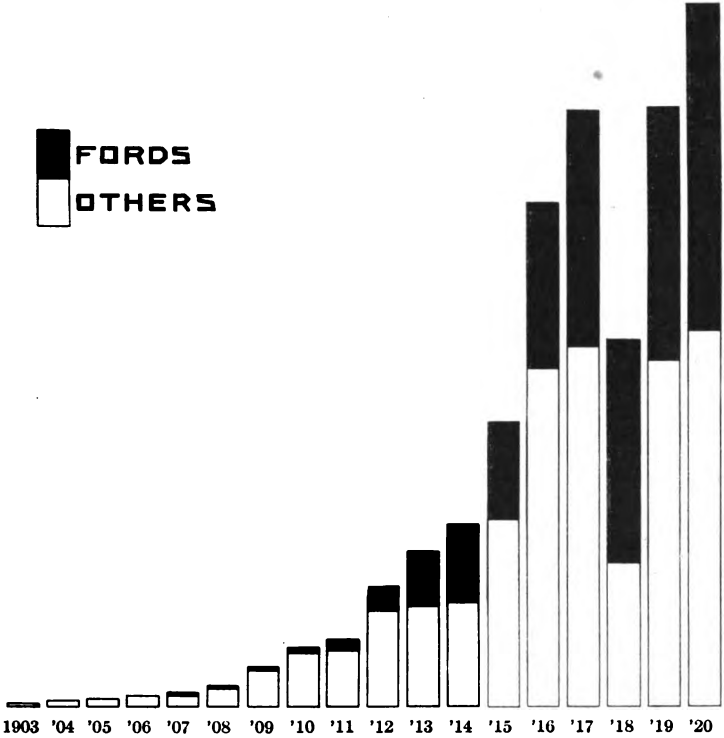


Diagram 3.—Ford cars and all other cars manufactured each year

the users of low priced machines. Practically all wealthy families, and a large proportion of those in moderate circumstances, now own machines. The same generalization can be made with regard to nearly all prosperous business and industrial establishments and a large part of those that are no more than fairly successful.

These individuals and firms of more than average money resources constitute the market for the more expensive vehicles. In the main this market has already been supplied and its future requirements will be largely for replacements and for gradual extension as economic well-being becomes more generally diffused.

These statements are supported by the statistics showing the number of Ford cars and other cars produced each year that have already been given in Table 3 and are presented in graphic form in Diagram 3.

In Diagram 3 each column represents the whole number of cars manufactured each year. The upper portion in black represents the Ford cars, while the lower part in outline is proportional in height to the number of all other cars manufactured in that year. The significant fact shown by the diagram is that the great growth in the annual output of the industry since 1916 has largely been in the Ford cars. If data were available to include for each year the number of other low priced cars, such as the Chevrolets, Dodges, Maxwells, and Overlands, it would be even clearer that the annual domestic market for more expensive cars has increased little if at all during the past five years.

REPLACEMENTS

The available figures indicate that about 8,500,000 automobiles were in use during 1920, and it seems certain that the number used in 1921 will be well in excess of 9,000,000. If the average length of service of the machines continues to be about six seasons, and if the number in use should not increase or diminish, this would require an annual replacement of no fewer than 1,500,000 machines per year. Up to the present time no such replacement figures have been even approached, but they are certain to come unless the use of automobiles markedly decreases. Most of the machines now in use are comparatively new. They are the output of the past five years, during which the annual production has been from 1,500,000 to more than 2,000,000 except for the war year of 1918. Previous to 1916 the

output each year was much smaller. At the present time about half the machines in use are less than three years old.

In 1916 the number of new cars other than Fords exceeded for the first time 1,000,000, and each year since, except in 1918, it has been slightly in excess of that figure. This year the cars made in 1916 are in the sixth year of their service and it seems clear that before long the replacement market for such cars will be in the neighborhood of 1,000,000 annually.

The chief difficulty in the way of making a closer estimate is our lack of knowledge of the duration of service of the better cars. It seems certain that the improved quality of the more expensive cars made in recent years is increasing their term of use and this tends to cut down the prospective replacement market. The principle involved is that if the whole number in use remains constant, the replacement cars needed each year will be equal to the number used divided by their average length of service in years. Thus if there should be 6,000,000 of the higher priced cars in use over a considerable term of years, and the average length of service should be six years, the annual replacements would be 1,000,000. But if the quality of cars should improve so that the average use was 10 years, the number of annual replacements would fall to 600,000.

It is sometimes suggested that the number of cars in use may actually decrease now that the abnormal wages of the war period are past. To the writer it seems improbable that anything short of a prolonged era of serious business depression can force many people who now have cars to give them up and do without. During recent weeks the writer has asked many people in different walks of life under what conditions they would sell their machines and do without. The replies are uniformly to the effect that only prolonged adversity of a severe sort would force such a sacrifice. It seems plain that after people have become accustomed to using automobiles they will not give them up unless virtually forced to do so.

PRODUCTIVE CAPACITY

The productive capacity of the automobile industry in this country has been stated to be 2,660,000 cars a year at the close of 1920. This figure is probably fairly accurate, for the cars produced in 1920 were about 2,200,000, with curtailed operations prevailing in the last three or four months. As new plants have since been completed, the country's present annual capacity is somewhat greater and may perhaps be in the neighborhood of 2,750,000. It almost surely lies somewhere between 2,500,000 and 2,750,000.

If all these plants should produce cars at their full capacity and if the cars should last on the average long enough to be registered during six seasons, the annual registration would soon be from 15,000,000 to 16,500,000.

It has already been pointed out that registration figures are in excess of the number of cars actually in use at any one time, and the difference between the two numbers is equal to the annual elimination. This means that if the present productive capacity should be utilized to the full over a period of some years, and all the cars were used in this country, there would have to be from 12,500,000 to 13,750,000 actually operated to consume the annual output. If improved construction, more intelligent use, and better roads should increase the average term of service of the cars to eight years instead of six, the number in use would have to be about 17,000,000 or 18,000,000 to take care of the production. This would mean that the number of cars in use would have to be twice as great as it is now to utilize our present car manufacturing capacity.

The use in the near future of anything like twice the present number of motor vehicles seems most unlikely. It is probably true at present that not far from half the white American families already have them, and this half includes practically all the wealthy, the comfortably well-to-do, and a large number who can barely afford to purchase and run their cars. The families and the businesses that have not as yet become users of motor cars are largely those who so far have been unable to

afford them, and it seems quite unreasonable to suppose that the poorer half of American families and firms can purchase motor cars with anything like the ease and rapidity that have marked their acquisition by their wealthier neighbors. Another consideration of no small importance is that if the number of automobiles should be doubled in the near future some other motive power than gasoline would probably have to be developed to propel them.

The present situation of the industry seems not unlike that faced by many establishments producing military supplies and equipment during the war, when it was emphatically demonstrated that the productive capacity needed to supply the initial equipment quickly was greatly in excess of that required for furnishing replacements later on. It appears that the country will shortly need about 1,500,000 cars annually if the use of automobiles remains at about its present status. Its productive capacity is more than 1,000,000 a year in excess of this.

There seem to be only two ways in which this capacity can be fully utilized. The first is through a continuing great increase in the use of cars until they are about twice as numerous as at present. The second is through building up an enormous export trade. In view of present economic conditions and future prospects here and abroad both solutions seem highly improbable of realization.

PRICES

Through the co-operation of the different manufacturers of motor vehicles the data presented in Table 10 have been compiled. They show the prices year by year of 25 standard makes of touring cars from 1913 to the present time. Of these cars five are four cylinder machines which are widely used, while the other 20 are well-known six cylinder machines. The attempt has been made in each case to get the typical price for each year on the same model over the entire period as nearly as this is possible in view of the great improvements that have been made.

TABLE 10.—PRICES OF STANDARD TOURING CARS FOR NINE YEARS

		1913	1914	1915	1916	1917	1918	1919	1920	Jan. 1921	July 1921
1.	Auburn	..	..	1,050	1,085	1,295	1,595	1,595	1,695	1,895	1,690
2.	Buick	1,285	1,335	1,235	1,020	1,070	1,265	1,595	1,495	1,795	1,525
3.	Chalmers	1,950	1,775	1,650	1,090	1,250	1,565	1,565	1,685	1,795	1,545
4.	Chandler	1,785	1,595	1,595	1,295	1,395	1,595	1,795	1,895	1,895	1,785
5.	Chevrolet	875	875	490	490	635	865	865	735	820	645
6.	Dodge	..	785	785	785	785	885	1,085	1,085	1,285	985
7.	Ford	550	490	440	360	360	525	525	525	440	415
8.	Franklin	2,900	2,300	2,150	1,950	1,950	2,250	2,650	2,850	2,700	2,650
9.	Haynes	2,700	2,785	1,550	1,495	1,725	2,150	2,485	2,685	2,935	1,985
10.	Hudson	2,250	2,350	2,350	1,650	1,650	1,975	2,100	2,200	2,400	2,250
11.	Kisselkar	2,500	2,350	1,650	1,485	1,295	1,385	1,645	2,975	3,475	3,475
12.	Locomobile	5,100	5,100	5,100	5,400	5,000	6,600	7,550	8,100	7,550	8,600
13.	Marmon	5,000	5,000	5,000	2,950	3,100	3,550	3,950	4,650	5,000	3,985
14.	Maxwell	750	695	695	595	745	895	995	985	995	845
15.	McFarlan	2,590	2,590	2,990	3,500	3,550	4,300	4,300	4,800	6,300	6,300
16.	Mitchell	..	1,250	1,250	1,325	1,425	1,510	1,475	1,750	1,750	1,490
10.	Moon	2,150	2,250	2,250	1,295	1,095	1,685	1,885	1,985	1,985	1,985
18.	National	2,375	2,375	2,500	1,750	1,995	2,450	2,450	3,290	3,750	2,990
19.	Oakland	1,075	1,785	1,200	875	990	1,185	1,075	1,165	1,395	1,145
20.	Overland	985	950	1,075	750	795	1,095	985	985	895	695
21.	Pierce Arrow	5,000	5,000	5,000	5,000	5,500	5,500	6,500	7,750	7,500	7,500
22.	Premier	2,785	2,700	2,300	1,685	2,285	2,585	2,585	4,300	4,600	3,890
23.	Stutz	2,050	2,150	2,275	2,550	2,550	2,750	2,850	3,350	4,000	3,350
24.	Velie	2,000	2,350	2,015	1,065	1,185	1,340	1,465	1,885	1,885	1,585
25.	Winton	3,250	3,500	3,500	2,335	2,735	3,000	3,200	4,250	4,600	4,600
	Total	51,905	53,085	52,095	43,753	46,360	54,500	59,170	69,070	73,640	67,915
	Average	2,359	2,308	2,084	1,750	1,854	2,180	2,367	2,763	2,946	2,717
	Median	2,200	2,200	1,600	1,200	1,300	1,500	1,700	1,900	1,900	1,900

The figures at the bottom of the table show the average and median prices of the 25 cars over these eight years. The median is a kind of average that is found by taking each year the middle price among the 25 prices in the column. The median price is such a price each year that there are 12 among the 25 cars that are cheaper, and 12 that are more expensive.

The course of the average and median figures shows that the typical prices of cars fell from 1913 to 1916 and rose from that point to the beginning of 1921, when they again began to decline. In order to measure the amounts of these changes three index numbers of car prices have been constructed. The price of each car has been taken as being represented by 100 in 1913 and the price in each subsequent year has been computed on this basis as being more or less than 100.

These relative figures have been added and averaged for each year, so as to give a single index number for the five low priced, four cylinder cars in the list. These are the Chevrolet,

Dodge, Ford, Maxwell and Overland. The same process has been carried through for the seven highest priced cars in the list, which are the Locomobile, McFarlan, Marmon, Pierce-Arrow, Premier, Stutz and Winton. A similar operation has been carried through for the remaining 13 medium priced, six cylinder cars. The results are presented in Table 11 and Diagram 4.

TABLE 11.—PRICE CHANGES SINCE 1913 OF THREE CLASSES OF TOURING CARS, THE PRICES IN 1913 BEING TAKEN AS EQUAL TO 100

Year	Five low priced cars	Thirteen medium priced cars	Seven high priced cars	25 cars
1913	100	100	100	100
1914	96	105	101	102
1915	88	92	102	94
1916	75	72	94	79
1917	84	77	99	85
1918	106	93	113	101
1919	113	98	122	108
1920	111	113	148	122
1921	112	122	163	131
1921 (July)	92	107	155	117

Per Cent.

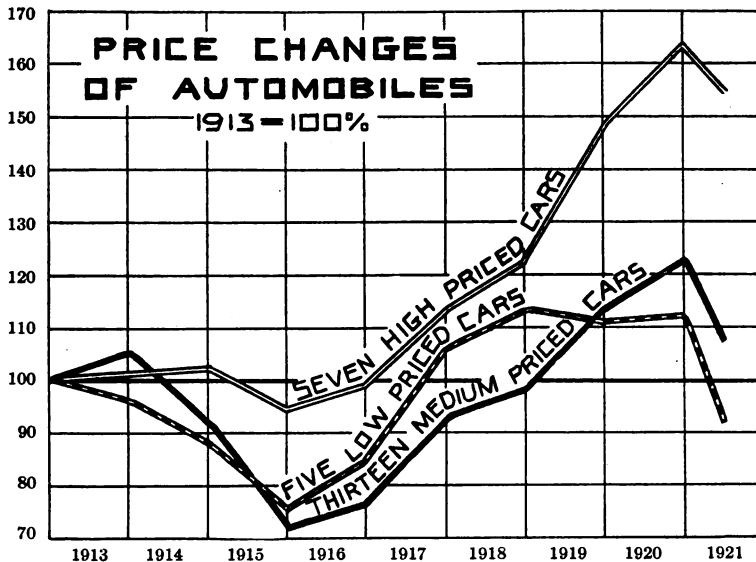


Diagram 4.—Price changes of three classes of touring cars during nine years

These changes in the price level are shown in graphic form in Diagram 4. During the period of increasing competition from 1913 to 1916, the prices of the medium grade cars fell most severely, and during the long period of expanding demand from 1916 to 1921 they rose steadily. At the peak of prices in the beginning of 1921 the typical medium priced car was selling for about 49 per cent more than in 1916.

The price changes among the low priced cars have been more rapid, but of smaller proportions. Their price advances from the low figures of 1916 came suddenly and were well maintained during the years of high commodity prices. Their reductions since the beginning of 1921 have been proportionately greater than those of the other cars.

The most expensive cars have advanced their prices with little interruption since 1913 until, in 1921, their general level of cost had risen to more than 60 per cent above the 1913 figures. Their reductions since the beginning of 1921 have been moderate.

The changes indicate that motor car prices have swung through a considerable range as costs and demand have changed with varying degrees of general prosperity and depression. The present indications suggest that even greater proportional changes may be expected in the future, as the industry, with its great productive capacity, competes for the sale of its output in markets where declining prices have sharply reduced the public's purchasing ability.

SUMMARY

1. Since the beginning of the automobile industry in America, 25 years ago, the number of cars manufactured up to the beginning of 1921 has been about 11,775,000, of which more than 700,000 have been exported. About 9,000,000 are in use, and 2,000,000 have been worn out, destroyed, or abandoned.

2. The average term of service has been about six seasons.

3. By the end of 1920 there was one car in use for each 12 people in the population.

4. The theoretical number of possible purchasers of motor vehicles seems to be limited to about 20,000,000. This is about the number of white, native-born men above the age of 21. It is also about the number of white American families. It is also about the number of persons earning money whose occupations are such as to make it appear possible that they might become motor car owners.

5. At the end of 1920 there were about 42 cars in use for each 100 native white men of voting age. The number varied in different parts of the country from about 22 cars per 100 men in the East South Central states to 60 cars per 100 men in the Pacific states.

6. It seems impossible to compute any saturation point for the industry because the number of cars demanded will apparently depend for many years to come on the general prosperity of the country.

7. It appears certain that for some years to come new users of automobiles will largely be people of limited means who will purchase inexpensive cars.

8. Since 1916 the increases in the annual output of automobiles have largely been accounted for by the expanding output of Ford cars and of other relatively inexpensive makes.

9. Up to the present time the replacement market has never exceeded 500,000 cars in a year, but there is every prospect that it will shortly amount to at least 1,500,000 cars per year.

10. Present productive capacity of the automobile industry is more than 1,000,000 cars per year greater than would be required to maintain the existing use of machines in a constant status.

11. Unless exports of cars increase enormously it appears that the present productive capacity of the industry would be sufficient nearly to double the number of cars in use within the next few years. It appears extremely doubtful if foreign or domestic markets can be sufficiently expanded to take care of this capacity, and if they could it seems probable that some

motive power other than gasoline would have to be developed to propel the cars.

12. It seems probable that extensive price adjustments will be made in the next few years, as the industry, with its great capacity, competes for purchasers among people and countries whose buying power has recently been sharply curtailed.



