TRENDS OF MOTOR VEHICLE REGISTRATIONS, TRAVEL AND REVENUE IN MICHIGAN

MICHIGAN STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER, STATE HIGHWAY COMMISSIONER

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This report presents a forecast of the number of motor vehicles, their travel, and the resulting direct tax receipts at 1946 rates in Michigan. It is in four parts:-

Conclusions

Summary of Trend Computations

Detail of Trend Computations and Summary Tables

Appendix:- Charts and Tables

Estimates of travel are needed for highway planning and design purposes. Roads and streets are built now to serve for many years. Their location and structural design should fit the anticipated needs.

Estimates of income available for highway purposes are essential to proper administration and programming of highway development.

The estimates developed in this report are based on long-term trends. It is not expected that travel or tax receipts will necessarily approximate the figures indicated for any specific year.

The war's effect on the trends is disregarded. It is assumed that actual travel and tax receipts will reach the established trends when the supply of motor vehicles meets the demand and the retirement of motor vehicles again follows the pre-war experience. This is expected to occur in 1951, after which this forecast is useable.

The trends established in this study are on four bases:-

1. Population.
2. Number of people per motor vehicle.
3. Motor fuel tax per composite motor vehicle.
4. Weight tax per composite motor vehicle.

The estimates are prepared by analysis of available data. They will require revision from time to time as actual deviations from estimated trends become apparent, or as the influence of certain factors on any of the four bases is determined. Some of these factors are:-

The effect of various social and economic conditions on the population of Michigan.

The effect of changes in amount and distribution of the national income on motor vehicle ownership and use.

The influence of the quality of the highway system and its terminal facilities on motor vehicle use.

The effect of vehicle characteristics such as weight and the amount and type of fuel consumed on tax revenues.

The effect of changes in the tax structure on motor vehicle use and revenues.

The forecasts are generally reliable until such time as a major deviation can be identified as producing an actual change in the trend.

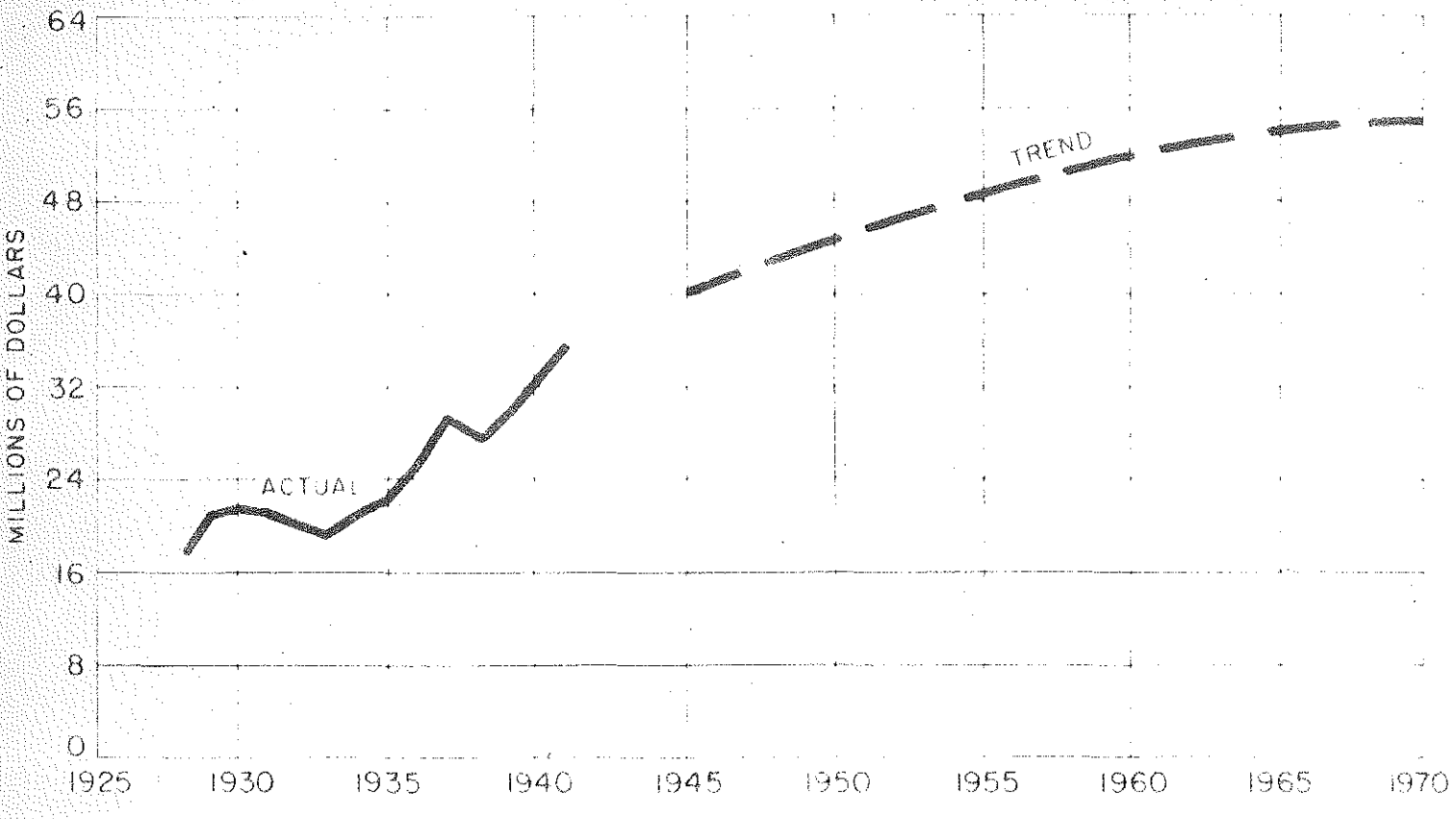
CONCLUSIONS

ESTIMATED ANNUAL NET MOTOR VEHICLE TAX RECEIPTS
(1946 rates)

YEAR	MOTOR FUEL TAX (Dollars)	WEIGHT TAX (Dollars)
1941 1/	35,475,347	23,936,574
1950	45,170,000	30,320,000
1955	49,138,000	33,070,000
1960	52,090,000	35,135,000
1965	54,177,000	36,620,000
1970	55,656,000	37,700,000

1/ 1941 receipts as reported by the Secretary of State.

MICHIGAN MOTOR FUEL TAX RECEIPTS
1927-1970



MICHIGAN WEIGHT TAX RECEIPTS
1925-1970

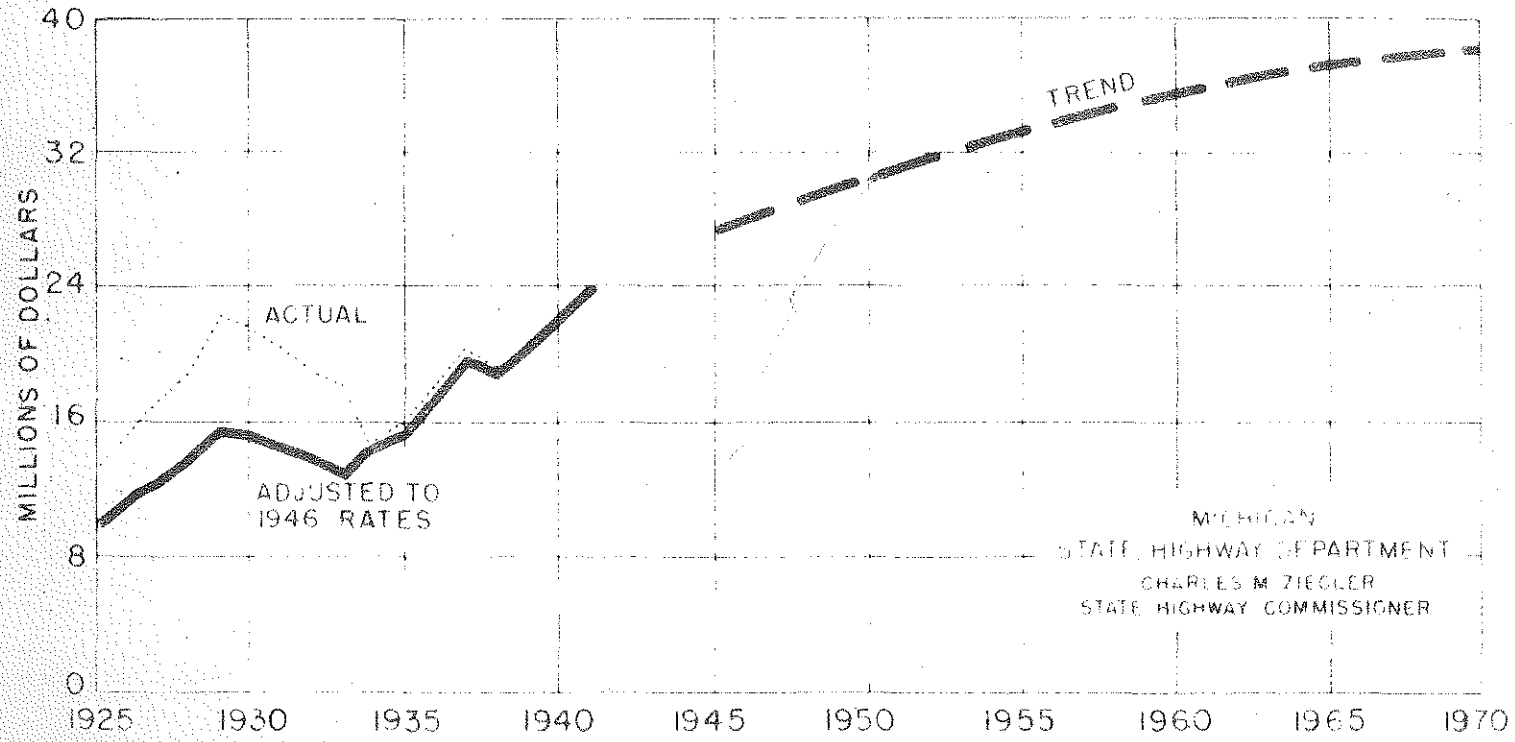


CHART A1

Chart A shows the trend of the estimated motor vehicle tax receipts from 1945 to 1970. The forecasts are based on these trends, the computation of which is described in this report.

The forecasts are conservative for the following reasons:-

---Latest estimates from the same source indicate a larger national population than that upon which these forecasts are based.

---The trends are derived from data which reflect the gradual development of the use of motor vehicles. Data from the years of rapid expansion (up to 1930) are not used in these calculations.

---The future trend of the weight of motor vehicles has been assumed to be in the direction of lighter vehicles than the existing trend indicates.

SUMMARY OF TREND COMPUTATIONS

Sources of information and methods by which the trends were calculated are indicated in this summary in sequence of computation.

1. U. S. Population (forecast).

   "Estimated Future Population" by W. S. Thompson and P. K. Whelpton, of the Scripps Foundation for Population Research. Statistical Abstract of the U. S., 1944-45, Table No. 24, page 27.

2. Michigan's Percent of the U. S. Population.
   A revision and extension of data developed by the Highway Planning Survey in 1938.

3. Michigan Population.
   The prognosticated U. S. population multiplied by the percent estimated for Michigan.

4. Persons per Motor Vehicle.
   Past population divided by past motor vehicle registrations extended to a future apparent minimum.

5. Michigan Motor Vehicle Registration.
   Estimated population divided by estimated persons per motor vehicle.

6. Annual Net Motor Fuel Tax Receipts per Motor Vehicle (1946 rates).
   A Gompertz growth curve was applied to data for the years 1927-41, inclusive, and extended to 1970.

7. Annual Net Motor Fuel Tax Receipts (total at 1946 rates).
   Estimated registration multiplied by the estimated motor fuel tax per motor vehicle.

8. Total Annual Travel.
   Motor fuel tax total, offset one month, converted to vehicle miles.

9. Annual Travel per Motor Vehicle.
   The estimated total travel divided by the estimated registration.

10. Annual Weight Tax per Motor Vehicle (1946 rates).
    A Gompertz growth curve was applied to two sets of data for the years 1932-43 and 1933-44, inclusive. This provides a minimum and a maximum trend, the selection of which will depend on facts and assumptions relating to the number and size of commercial vehicles.

11. Annual Total Weight Tax.
    Estimated registration multiplied by estimated tax per motor vehicle. Maximum and minimum estimates are developed.

DETAIL OF TREND COMPUTATIONS and SUMMARY TABLES

Equations are developed to express each trend.

Trend curve equations are derived directly from basic data for the following (numbered as indicated in "Summary"):-

1. U. S. Population (forecast).
2. Michigan's Percent of the U. S. Population.
4. Persons per Motor Vehicle.
6. Annual Net Motor Fuel Tax Receipts per Motor Vehicle.
10. Annual Weight Tax per Motor Vehicle.

Trend curve equations are derived from a combination of other trend values for the following:-

3. Michigan Population.
5. Michigan Motor Vehicle Registration.
7. Annual Net Motor Fuel Tax Receipts.
8. Total Annual Travel.
9. Annual Travel per Motor Vehicle.
11. Annual Total Weight Tax.

For the latter group, the combination of trend values (in each case), is then expressed by a new equation, closely representing the derived values. This is done for convenience in subsequent computations. Data in this group of equations for the years prior to 1945 are used only to aid in establishing the algebraic equations.

Fourth degree parabolic curves of the form

$$Y = A + B X + C X^2 + D X^3 + E X^4$$

have been selected to represent trends derived directly or indirectly from population data. These curves were computed with the origin at 1950 and a time interval of 5 years on the X axis.

$X_{1930} = -4$		$X_{1955} = 1$
$X_{1935} = -3$	$X_{1950} = 0$	$X_{1960} = 2$
$X_{1940} = -2$		$X_{1965} = 3$
$X_{1945} = -1$		$X_{1970} = 4$

Gompertz growth curves of the form

$$Y = ab^{c^x}$$

have been selected to represent trends relating to tax computations per motor vehicle. These curves were computed with a time interval of one year on the X axis and an origin as indicated.

The following pages contain the explanation of the computations for each equation and a summary of the resulting data. The appendix contains the detailed basic or historical data, computed and derived data.

1. United States Population

United States population data for the years 1920-1940, inclusive, were obtained from the Bureau of Census of the U. S. Department of Commerce. Estimated population for the years 1945-1980, inclusive, are from the National Resources Planning Board, "Estimates of Future Population of the United States," by W. S. Thompson and P. K. Whelpton, of the Scripps Foundation for Population Research. The estimates are based on the assumption of medium fertility, medium mortality, no immigration, and no war losses, without correction for the underenumeration of infants. This data is published in the "Statistical Abstract for the United States 1944-45" in Table No. 24 on page 27, and are shown in Table 1 of this report.

After plotting the above estimates for the years 1940-1980, inclusive, it was found that they fitted a fourth degree parabolic curve of the form

$$Y = A + B X + C X^2 + D X^3 + E X^4,$$

developed by the method of least squares. Therefore, the relationships subsequently developed in this report are based on the estimated population trend--not on the actual population prior to 1940.

U. S. population figures for the selected years were expressed as 100.00 times their ratios to the actual population in 1940 (131,669,275). A fourth degree curve was then passed through those ratios by the method of least squares. The equation of the curve is:

$$Y = 108.274 + 3.627 X - .222 X^2 - .00606 X^3 + .00044 X^4.$$

The computed trend is shown in Table 1. For detailed data, see Appendix, Tables A-1 and A-2.

TABLE 1

UNITED STATES POPULATION

YEAR	ACTUAL AND ESTIMATED 1/ (Number)	Ratio 3/	TREND (Number)	Ratio 3/
1920	105,710,620	80.28	105,861,000	80.399
1925	115,832,000 2/	87.97	112,738,000	85.622
1930	122,775,046	93.25	119,440,000	90.714
1935	127,250,000 2/	96.64	125,870,000	95.594
1940	131,669,275	100.00	131,920,000	100.188
1945	137,512,000 1/	104.44	137,500,000	104.432
1950	142,942,000	108.56	142,560,000	108.274
1955	147,287,000	111.86	147,040,000	111.673
1960	150,773,000	114.51	150,890,000	114.599
1965	153,814,000	116.82	154,090,000	117.029
1970	156,549,000	118.90	156,630,000	118.955

1/ 1945-1970, inclusive--Estimate by Thompson & Whelpton.
2/ 1925, 1935, Mid-year estimates, Bureau of the Census.
3/ U.S. population, 1940 (131,669,275) = 100.00

2. Michigan's Percent of the U. S. Population

No studies of future population of Michigan have been found except those prepared by the Michigan Highway Planning Survey in 1938. That estimate was prepared on the basis of the trend in Michigan's percent of the U. S. population and that method is followed in this estimate. The 1938 trend was revised, as actual percentages for 1938 through 1944 indicated that the trend developed from 1937 and earlier data indicated a greater increase than actually occurred.

The equation of the curve (developed by the method of least squares) representing Michigan's percent of U. S. population is:

$$Y = 4.4 + .13\ X - .013\ X^2 - .001\ X^3 + .00011\ X^4.$$

Table 2 shows the actual percentages and the percentages derived from the above equation, representing the trend. For detailed data, see Appendix, Tables A-1 and A-2.

TABLE 2

MICHIGAN'S PERCENT OF THE U. S. POPULATION

YEAR	ACTUAL (percent)	TREND (percent)
1920	3.47	
1925 1/	3.70	
1930	3.94	3.758
1935 1/	3.80	3.925
1940	3.99	4.096
1945		4.258
1950		4.400
1955		4.516
1960		4.600
1965		4.651
1970		4.670

1/ Mid-year estimates, Bureau of the Census.

3. Michigan Population

The Michigan population trend was computed by multiplying U. S. population derived from the trend equation for the years 1930-1970, inclusive, by Michigan's percent of U. S. population derived from its trend equation. The results were expressed as 100.00 times their ratios to the actual 1940 population (5,256,106). A fourth degree curve was developed from those ratios by the method of least squares. The equation of the curve is:

$$Y = 119.349 + 7.509\ X - .493\ X^2 - .0494\ X^3 + .0032\ X^4.$$

The Michigan population trend determined by the above equation is shown in Table 3. For detailed data, see Appendix, Table A-2.

TABLE 3

TREND OF MICHIGAN POPULATION

YEAR	NUMBER	RATIO 1/
1945	5,855,000	111.400
1950	6,273,000	119.349
1955	6,639,000	126.319
1960	6,941,000	132.051
1965	7,167,000	136.362
1970	7,314,000	139.155

1/ Census population in 1940 (5,256,106) = 100.00

4. Persons per Motor Vehicle

The term "motor vehicle" as used in this report is defined as follows:

All vehicles registered by the Secretary of State in the following classifications:

Passenger cars
Commercial vehicles
Farm vehicles
Hearses and ambulances

Foreign or out-of-state registrations in these four classes are included, but all publicly-owned vehicles are excluded.

When the 1938 trends were computed, the conclusion was that persons per motor vehicle would be no less than 3.10. Upon examining actual data through 1944, no reason was found to change that assumption. Therefore, the figure denoting persons per motor vehicle was leveled off at this amount and a fourth degree curve passed through the previous trend figures. The equation of the resulting curve is as follows:

$$Y = 3.12 - .0252\,X + .0136\,X^2 - .00273\,X^3 + .00014\,X^4.$$

Table 4 shows the actual number of persons per motor vehicle in Michigan, and the trend calculated from the above equation. For detailed data, see Appendix, Tables A-1 and A-3.

TABLE 4

PERSONS PER MOTOR VEHICLE

YEAR	ACTUAL (Number)	TREND (Number)
1930	3.64	3.65
1935	3.90	3.40
1940	3.38	3.25
1945		3.16
1950		3.12
1955		3.11
1960		3.10
1965		3.10
1970		3.10

5. Michigan Registration

The trend for registrations was developed for motor vehicles only, as defined in item 4.

The registration trend was computed by dividing the Michigan population derived from its trend equation by the number of persons per motor vehicle, derived from its trend equation. The results were expressed as 100.00 times their ratios to the actual 1941 registration of motor vehicles (1,708,191). A fourth degree curve was developed from those ratios by the method of least squares. The equation of the curve is:

$$Y = 117.639 + 8.457\ X - .882\ X^2 - .01135\ X^3 + .006\ X^4.$$

Table 5 shows the registration trend based on the equation developed. For detailed data, see Appendix, Table A-3 and Chart 1.

TABLE 5

TREND OF MICHIGAN MOTOR VEHICLE REGISTRATION

YEAR	NUMBER	RATIO 1/
1945	1,850,000	108.317
1950	2,009,000	117.639
1955	2,139,000	125.209
1960	2,238,000	131.030
1965	2,310,000	135.252
1970	2,360,000	138.165

1/ Registration, 1941 (1,708,191) = 100.00

6. Annual Net Motor Fuel Tax Receipts per Motor Vehicle

The Highway Planning Survey prepared a forecast in 1938 of the total of motor fuel taxes which was reviewed at the beginning of this study. Actual data now available (exclusive of the war years) indicated that the 1938 estimates were too high for the fifteen year period following 1938. That estimate was based on travel per motor vehicle, derived from several sources.

It was necessary to find a better base and to determine an equation representing a curve which would more closely approximate actual data and at the same time extend that data into the future at a reasonable rate.

The base finally selected was annual net motor fuel tax receipts (after refunds) per motor vehicle (as previously defined) for the years 1927-41, inclusive, as reported by the Secretary of State. A tax rate of two cents per gallon prevailed for part of the year 1927. Consequently, the total receipts for that year were adjusted to reflect a three cent rate for the full year. Receipts subsequent to 1927 have all been at the rate of three cents per gallon.

A Gompertz growth curve of the form

$$Y = ab^{c^x}$$

was selected as representing a close approximation of the rates of increase in motor fuel tax receipts per motor vehicle.

The equation, expressed in logarithmic form, is:

$\text{Log } Y = 1.3759991 - .225976\ (.907563)^x$. (Point of origin is 1927).

Table 6 shows the actual net motor fuel tax receipts (after refunds) per motor vehicle and the receipts estimated by the Gompertz equation representing this trend. For detailed data, see Appendix, Tables A-1 and A-4, and Chart 2.

TABLE 6

ANNUAL NET MOTOR FUEL TAX RECEIPTS PER MOTOR VEHICLE

YEAR	ACTUAL (Dollars)	TREND (Dollars)
1930	16.3160	16.1097
1935	18.3276	18.7067
1940	20.8343	20.5099
1945		21.7056
1950		22.4762
1955		22.9642
1960		23.2699
1965		23.4602
1970		23.5782

7. Net Total Motor Fuel Tax Receipts

The trend of the net total motor fuel tax receipts was obtained by multiplying the registration (derived from its trend equation) by the motor fuel tax per motor vehicle (derived from its trend equation). The results were expressed as 100.00 times their ratios to the actual 1941 motor fuel tax ($35,475,347). A fourth degree curve was developed from those ratios by the method of least squares. The equation of the curve is:

$$Y = 127.3270 + 12.68726\ X - 1.5103811\ X^2 - .00314293\ X^3 + .0124157\ X^4.$$

Table 7 shows net motor fuel tax receipts from the equation representing the trend. For detailed data, see Appendix, Table A-4 and Chart 3.

TABLE 7

TREND OF ANNUAL NET MOTOR FUEL TAX RECEIPTS

YEAR	DOLLARS	RATIO 1/
1945	40,138,000	113.1449
1950	45,170,000	127.3270
1955	49,139,000	138.5132
1960	52,090,000	146.8335
1965	54,177,000	152.7162
1970	55,656,000	156.8872

1/ Net motor fuel tax receipts, 1941 ($35,475,347) = 100.00

8. Annual Total Travel

The estimate of total travel in vehicle miles is based on net motor fuel tax receipts. During the calendar month, the tax is paid on sales of the preceding month; e.g., January tax receipts represent the gasoline used by motor vehicles during December of the preceding year. The Highway Planning Survey determined the vehicle miles of travel in Michigan in 1936 to be 11,741,705,000. The net motor fuel tax receipts from February 1, 1936, through January 31, 1937 (the period comparable to the travel) was $26,112,546.

To compute the travel trend, the trend of net motor fuel tax receipts was offset one twelfth of the year and the resulting tax receipts converted to travel, using the 1936 relationship.

Table 8 shows the vehicle miles estimated from the gas tax trend offset one month. For detailed data, see Appendix, Tables A-4 and A-5.

TABLE 8

TREND OF TOTAL TRAVEL

YEAR	VEHICLE MILES	RATIO 1/
1945	18,090,000,000	112.1896
1950	20,345,000,000	126.1708
1955	22,121,000,000	137.1880
1960	23,441,000,000	145.3746
1965	24,374,000,000	151.1593
1970	25,036,000,000	155.2651

1/ Vehicle miles of travel in 1941 (16,124,620,000) = 100.00

9. Annual Travel per Motor Vehicle

Average travel per motor vehicle per year was computed by dividing the total estimated travel by the estimated registration. No mathematical curve was developed, but the resulting data was plotted, and a curve drawn through the points was used as the trend curve.

Table 9 shows the vehicle miles per motor vehicle estimated from the trend of total travel divided by the trend of registration. For detailed data, see Appendix, Table A-5.

TABLE 9

TREND OF ANNUAL TRAVEL PER MOTOR VEHICLE

YEAR	MILES	RATIO 1/
1945	9,777	103.57
1950	10,124	107.25
1955	10,343	109.57
1960	10,473	110.94
1965	10,550	111.76
1970	10,608	112.37

1/ Travel in 1941 (9,440 miles) = 100.00

10. Annual Weight Tax per Motor Vehicle

In this study "motor vehicles" have been defined to include registered passenger cars, commercial vehicles, farm vehicles, hearses and ambulances. Weight taxes at varying rates are paid on these vehicles and, in addition, weight taxes are paid for trailers (commercial), house trailers, motorcycles and manufacturers' and dealers' plates.

Weight taxes paid in 1941 for motor vehicles totaled $22,369,508. The remaining weight taxes totaled $1,567,266, or only 6.5 per cent of the total. Therefore, further analysis was simplified by including all weight taxes as reported by the Secretary of State, but analyzing them on the basis of registered motor vehicles for which trends and forecasts have been made.

The following rate changes have been placed in effect since 1925:

Passenger cars - from 55 to 35 cents per CWT in 1934

Farm commercial - from commercial rates to 35 cents per CWT in 1938.

Hearses, ambulances - from commercial rates to 50 cents per CWT in 1938.

Data for years prior to these changes were adjusted to the present rates by the following means:

Passenger cars	—tax receipts reduced to 35/55 for years prior to 1934.
Farm commercial Hearses and ambulances	—estimates were made of the number of these vehicles which were included in commercial vehicles prior to 1938. A reducing factor was then computed for each year.

Because of the relatively rapid growth in the numbers and average weight of commercial vehicles, and a gradual increase in the average weight of passenger cars during the 1930's, the trend of total weight tax per composite motor vehicle appeared to be rising at a rate considered to be excessive. A separate study disclosed that, in the latter years of that decade and the early 1940's, average passenger car weight was already nearly constant. Published statements indicate that such weights may be reduced in the post-war years, especially in the lower-cost, higher-volume market.

The average weight of commercial vehicles will probably continue to rise, although not at the rates found in the 1930's. This appears probable for the following reasons:

—a larger percentage of commercial vehicles may be expected on the basis of past growth, dispersion of industry away from rail locations, and the apparent economy and superior service of motor carriers for shorter hauls.

—a greater number of commercial vehicles are in the heavier weight classifications.

—the possibility of increased size and weight limits as highways are improved.

—the possibility that present laws may be changed to place commercial trailers on a higher rate schedule, even if present rates on trucks and tractors are retained.

Offsetting these prospects are the possibilities of

—stronger and lighter construction of commercial vehicles and trailers to permit greater pay loads.

—competition from other forms of transportation, tending to reduce use of motor vehicles.

—congestion, limiting the growth of motor truck use to a lesser rate of increase.

Data was selected to reflect conservative judgment of the influence of these various factors, and two Gompertz growth curves and equations based on the selected data were developed.

The two curves are based on the annual weight tax per motor vehicle for two time periods, 1932-1943 and 1933-1944, both inclusive. Since new truck manufacture and sales practically ceased during the war, the trend rates are reduced by the inclusion of two or three war years and the exclusion of the phenomenal rise in average commercial vehicle weights in the late 1920's and early 1930's.

A reliable estimate of the trend of the actual annual weight tax per motor vehicle will be found between the maximum and minimum estimates developed herein. The choice will depend upon post-war developments not clearly foreseeable at this time.

The equations of the two selected curves are:-

For the period 1932-1943, inclusive (maximum estimate):

$\text{Log } Y = 1.2078798 - .1451845\ (.914906)^{x}$. Origin is 1932.

For the period 1933-1944, inclusive (minimum estimate):

$\text{Log } Y = 1.1764492 - .1079178\ (.865598)^{x}$. Origin is 1933.

Table 10 shows the maximum and minimum estimated weight tax per motor vehicle (adjusted to 1946 rates), derived from the above equations. For detailed data, see Appendix, Tables A-1 and A-6, and Chart 4.

TABLE 10

ANNUAL WEIGHT TAX PER MOTOR VEHICLE
(Adjusted to 1946 rates)

YEAR	ACTUAL	TREND	
		Maximum	Minimum
	(Dollars)	(Dollars)	(Dollars)
1930	11.5393	10.8246 1/	10.5000 1/
1935	12.4409	12.4936	12.4621
1940	13.7794	13.6962	13.7138
1945	14.5610	14.5274	14.3666
1950		15.0865	14.6950
1955		15.4562	14.8573
1960		15.6980	14.9368
1965		15.8549	14.9756
1970		15.9564	14.9945

1/ Extrapolated from trend.

11. Annual Total Weight Tax

A maximum and a minimum trend have been developed for the reasons and on the basis explained in item 10.

Estimates derived from each of the two developed trends for annual weight tax per motor vehicle were multiplied by the registration estimates as derived from the trend of motor vehicle registration. The results were expressed as 100.00 times their ratios to the actual 1941 total weight tax ($23,936,574). A fourth degree curve was developed from those ratios, by the method of least squares to express the trend of the annual total weight tax.

The equations of the curves, based on the two periods, are:-

Based on the period 1932-1943, inclusive (maximum estimate):

$$Y = 126.66 + 12.9653\ X - 1.4783\ X^2 - .014019\ X^3 + .0137476\ X^4.$$

Based on the period 1933-1944, inclusive (minimum estimate):

$$Y = 123.44 + 10.9395\ X - 1.5496 + .05132\ X^3 + .00864\ X^4.$$

Table 11 shows the estimates of annual total weight tax (adjusted as described in item 10) derived from the two trend equations stated in this item. For detailed data, see Appendix, Table A-6 and Chart 5.

TABLE 11

TRENDS OF ANNUAL TOTAL WEIGHT TAX
(Adjusted to 1946 rates)

YEAR	MAXIMUM ESTIMATE		MINIMUM ESTIMATE	
	Dollars	Ratio 1/	Dollars	Ratio 1/
1945	26,870,000	112.2442	26,550,000	110.9092
1950	30,320,000	126.6600	29,550,000	123.4400
1955	33,070,000	138.1467	31,810,000	132.8889
1960	35,135,000	146.7852	33,430,000	139.6674
1965	36,620,000	152.9862	34,565,000	144.3946
1970	37,700,000	157.4906	35,400,000	147.8967

1/ Total weight tax in 1941 ($23,936,574) = 100.00

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TABLE A - 1

BASIC DATA

Year	U. S. Population		Michigan Population		Motor Vehicle Registration		Annual Net Motor Fuel Tax Receipts 4/				Weight Tax Receipts 4/			
							Calendar Year		Offset 1 Month		Actual		Adjusted to 1946 Rates	
	Number 1/	Ratio (1940 = 100.00)	Number 2/	Ratio (1940 = 100.00)	Number	Ratio (1941 = 100.00)	Dollars	Ratio (1941 = 100.00)	Dollars	Ratio (1941 = 100.00)	Dollars	Ratio (1941 = 100.00)	Dollars	Ratio (1941 = 100.00)
1920	105,710,620	80.28	3,668,412	69.79	412,717	24.16					5,482,853.45	22.91		
1921	108,541,000	82.43	3,792,000	72.14	477,037	27.93					6,261,496.38	26.16		
1922	110,055,000	83.58	3,916,000	74.50	578,980	33.89					7,545,884.42	31.52		
1923	111,950,000	85.02	4,040,000	76.86	730,658	42.77					9,468,372.55	39.56		
1924	114,113,000	86.67	4,164,000	79.22	868,587	50.85					11,261,282.29	47.05		
1925	115,832,000	87.97	4,288,000	81.58	990,709	58.00					13,356,466.46	55.80	9,517,495.74	39.76
1926	117,399,000	89.16	4,413,000	83.96	1,120,441	65.59					15,745,859.73	65.78	11,383,584.33	47.56
1927	119,038,000	90.41	4,527,000	86.13	1,156,344	67.69	16,385,400.00	46.19 3/			16,866,996.06	70.47	12,195,985.98	50.95
1928	120,501,000	91.52	4,642,000	88.32	1,251,221	73.25	17,874,089.23	50.38	18,366,266.89	51.22	18,773,358.39	78.43	13,556,347.29	56.63
1929	121,770,000	92.48	4,756,000	90.49	1,397,672	81.82	21,169,546.49	59.67	21,290,387.85	59.37	21,704,193.90	90.67	15,621,011.09	65.26
1930	122,775,046	93.25	4,842,325	92.13	1,330,582	77.89	21,709,716.00	61.20	21,695,834.80	60.50	21,335,616.77	89.13	15,353,976.43	64.14
1931	124,040,000	94.21	4,798,000	91.28	1,232,864	72.17	21,497,084.08	60.60	21,779,068.45	60.73	20,188,003.17	84.34	14,504,338.82	60.59
1932	124,840,000	94.81			1,136,224	66.52	20,398,448.99	57.50	20,217,247.90	56.38	18,710,257.11	78.17	13,410,656.70	56.03
1933	125,579,000	95.37	4,780,000	90.94	1,078,757	63.15	19,458,457.78	54.85	19,276,182.17	53.75	17,584,045.85	73.46	12,550,200.84	52.43
1934	126,374,000	95.98			1,150,929	67.38	20,823,058.36	58.70	21,027,379.83	58.64	14,297,764.26	59.73	14,101,705.56	58.91
1935	127,250,000	96.64	4,838,000	92.05	1,242,022	72.71	22,763,304.79	64.17	23,017,172.94	64.19	15,659,639.70	65.42	15,451,847.49	64.55
1936	128,053,000	97.25			1,377,517	81.64	25,691,821.35	72.42	26,112,546.38	72.82	17,759,230.69	74.19	17,535,285.43	73.26
1937	128,825,000	97.84	4,968,000	94.52	1,508,906	88.33	29,375,155.27	82.80	29,285,183.42	81.67	19,690,631.09	82.26	19,454,404.78	81.27
1938	129,825,000	98.60	5,056,000	96.19	1,410,262	82.56	27,679,386.46	78.02	27,810,352.26	77.55	18,909,858.22	79.00	18,909,858.22	79.00
1939	130,880,000	99.40	5,156,000	98.10	1,474,058	86.29	29,788,542.40	83.97	30,008,451.85	83.68	19,935,345.06	83.28	19,935,345.06	83.28
1940	131,669,275	100.00	5,256,106	100.00	1,554,775	91.02	32,392,693.69	91.31	32,459,387.53	90.52	21,423,892.59	89.50	21,423,892.59	89.50
1941	133,203,000	101.16	5,404,000	102.81	1,708,191	100.00	35,475,346.66	100.00	35,859,773.95	100.00	23,936,573.99	100.00	23,936,573.99	100.00
1942	134,665,000	102.28	5,531,000	105.23	1,618,372	94.74	31,505,971.89	88.81	30,128,979.99	84.02	22,732,982.93	94.97	22,732,982.93	94.97
1943	136,497,000	103.67	5,423,000	103.18	1,536,265	89.94	23,088,700.88	65.08	23,443,596.57	65.38	21,594,023.16	90.21	21,594,023.16	90.21
1944	138,101,000	104.88			1,498,509	87.72	23,333,231.81	65.77	23,267,153.08	64.88	21,325,861.27	89.09	21,325,861.27	89.09
1945					1,475,152	86.36	26,047,257.33	73.42	26,504,955.74	73.91	21,479,666.36	89.74	21,479,666.36	89.74

1/ 1920, '30, '40, actual, Bureau of Census; other years, 1929-1944, mid-year estimates, Bureau of Census (1941-1944 include armed forces overseas).
2/ 1920, '30, '40, actual, Bureau of Census; other years, 1921-1943, mid-year estimates, Bureau of Census (1941-1943 inclusive do not include armed forces overseas or outside of the state).
3/ Adjusted to a rate of 3 cents per gallon for entire year.
4/ As reported by the Secretary of State.

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

TABLE A - 2

COMPUTATION OF THE TREND
of
POPULATION

Year	U. S. Population				Michigan's Percent of U. S. Population		Michigan Population			
	Actual & Estimated 1/		Trend		Actual & Estimated 3/	Trend	U.S. Population X Michigan's Percent 5/		Trend	
	Number	Ratio 2/	Number	Ratio 2/	Percent	Percent	Number	Ratio 4/	Number	Ratio 4/
1920	105,710,620	80.28								
1925	112,744,000	85.63			3.70					
1930	119,500,000	90.76	119,442,466	90.714	3.94	3.758	4,488,648	85.40	4,489,030	85.406
1935	125,750,000	95.50	125,867,927	95.594	3.80	3.925	4,940,316	93.99	4,939,583	93.978
1940	131,669,275	100.00	131,916,813	100.188	3.99	4.096	5,403,313	102.80	5,403,540	102.805
1945	137,512,000	104.44	137,504,857	104.432		4.258	5,854,957	111.39	5,855,302	111.400
1950	142,942,000	108.56	142,563,591	108.274		4.400	6,272,798	119.34	6,273,110	119.349
1955	147,287,000	111.86	147,039,029	111.673		4.516	6,640,283	126.33	6,639,461	126.319
1960	150,773,000	114.51	150,891,672	114.599		4.600	6,941,017	132.06	6,940,741	132.051
1965	153,814,000	116.82	154,091,236	117.029		4.651	7,166,783	136.35	7,167,331	136.362
1970	156,549,000	118.90	156,627,186	118.955		4.670	7,314,490	139.16	7,314,134	139.155
1975	158,500,000	120.38								
1980	160,045,000	121.55								

1/ 1920 and 1940, actual, Bureau of Census; 1925, 1930, and 1935 interpolated to conform to curve of 1945-1980 data; 1945-1980, inclusive, estimate by Thompson and Whelpton.
2/ U. S. Population, 1940, (131,669,275) = 100.00
3/ 1930 and 1940, actual, Bureau of Census; 1935, mid-year estimate, Bureau of Census.
4/ Michigan Population in 1940, (5,256,106) = 100.00
5/ U. S. Population (trend) multiplied by Michigan's percent of U. S. Population (trend).

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

TABLE A - 3

COMPUTATION OF THE TREND
of
MOTOR VEHICLE REGISTRATION

Year	Persons per Motor Vehicle		Registration of Motor Vehicles			
			Population ÷ Persons per Vehicle 1/		Trend	
	Actual	Trend	Number	Ratio 2/	Number	Ratio 2/
1930	3.64	3.65	1,229,871	72.00	1,229,231	71.961
1935	3.90	3.40	1,452,819	85.05	1,454,046	85.122
1940	3.38	3.25	1,662,628	97.33	1,663,505	97.384
1945		3.16	1,852,944	108.47	1,850,261	108.317
1950		3.12	2,010,612	117.70	2,009,499	117.639
1955		3.11	2,134,875	124.98	2,138,809	125.209
1960		3.10	2,238,949	131.07	2,238,243	131.030
1965		3.10	2,312,042	135.35	2,310,362	135.252
1970		3.10	2,359,398	138.12	2,360,122	138.165

1/ Michigan Population (trend) divided by persons per motor vehicle (trend).
2/ Registration, 1941 (1,708,191) = 100.00

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

TABLE A - 4

COMPUTATION OF THE TREND
of
ANNUAL NET MOTOR FUEL TAX RECEIPTS

Year	Motor Fuel Tax per Motor Vehicle		Annual Net Motor Fuel Tax Receipts			
			Registration X Tax per Vehicle 1/		Trend	
	Actual	Trend				
	Dollars	Dollars	Dollars	Ratio 2/	Dollars	Ratio 2/
1927	14.1700					
1928	14.2853					
1929	15.1463					
1930	16.3160	16.1097	19,802,543	55.82	19,792,193	55.7914
1931	17.4367					
1932	17.9528					
1933	18.0379					
1934	18.0924					
1935	18.3276	18.7067	27,200,402	76.67	27,231,692	76.7623
1936	18.6508					
1937	19.4678					
1938	19.6271					
1939	20.2085					
1940	20.8343	20.5099	34,118,321	96.17	34,104,154	96.1348
1941	20.7678					
1942	19.4677					
1943	15.0291					
1944	15.5710					
1945	17.6573	21.7056	40,161,025	113.21	40,138,546	113.1449
1950		22.4762	45,165,901	127.32	45,169,695	127.3270
1955		22.9642	49,116,038	138.45	49,138,038	138.5132
1960		23.2699	52,083,691	146.82	52,089,693	146.8335
1965		23.4602	54,201,555	152.79	54,176,602	152.7162
1970		23.5782	55,647,429	156.86	55,656,279	156.8872

1/ Registration (trend) times motor fuel tax receipts per motor vehicle (trend).
2/ Net motor fuel tax receipts, 1941, ($35,475,346.66) = 100.00

#5

#6

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

TABLE A - 5

COMPUTATION OF THE TREND
of
TOTAL TRAVEL

Year	Motor Fuel Tax Receipts Offset 1 Month 1/ Trend			Vehicle Miles				Vehicle Miles per Motor Vehicle			
				Computed		Trend		Computed		Trend	
	Dollars	Ratio 2/	Ratio 3/	Thousands	Ratio 4/	Thousands	Ratio 4/	Miles	Ratio 5/	Miles	Ratio 5/
1930	19,919,052	56.1490	55.5471	9,755,697	60.50	8,956,753	55.5471	7332	77.67	7,286	77.18
1935	27,351,776	77.1008	76.2743	10,349,847	64.19	12,298,934	76.2743	8333	88.27	8,458	89.60
1940	34,210,863	96.4356	95.4018	14,595,610	90.52	15,383,175	95.4018	9388	99.45	9,247	97.96
1945	40,230,923	113.4053	112.1896			18,090,140	112.1896			9,777	103.57
1950	45,244,548	127.5380	126.1708			20,344,555	126.1708			10,124	107.25
1955	49,195,295	138.6746	137.1880			22,121,038	137.1880			10,343	109.57
1960	52,130,986	146.9499	145.3746			23,441,094	145.3746			10,473	110.94
1965	54,205,372	152.7973	151.1593			24,373,857	151.1593			10,550	111.76
1970	55,677,705	156.9476	155.2651			25,035,903	155.2651			10,608	112.37

1/ Receipts for period February 1 through January 31.
2/ Net motor fuel tax for calendar year 1941 ($35,475,346.66) = 100.00
3/ Net motor fuel tax for period February 1, 1941 through January 31, 1942 ($35,859,773.95) = 100.00
4/ Vehicle miles in 1941 (16,124,620,000) = 100.00
5/ Vehicle miles per motor vehicle in 1941 (9440) = 100.00

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

TABLE A - 6

COMPUTATION OF THE TREND
of
WEIGHT TAX RECEIPTS

Year	Weight Tax per Motor Vehicle				Weight Tax Receipts							
					Tax per Vehicle X Registration							
					Maximum Estimate		Minimum Estimate		Trend			
									Maximum Estimate		Minimum Estimate	
	Actual	Adjusted to 1946 Rates	Trend Maximum	Trend Minimum								
	Dollars	Dollars	Dollars	Dollars	Dollars	Ratio 2/	Dollars	Ratio 2/	Dollars	Ratio 2/	Dollars	Ratio 2/
1930	16.03	11.54	10.8246	10.5000	13,305,933.88	55.59	12,906,925.50	53.92	13,299,782.86	55.5626	12,882,616.25	53.8198
1931	16.37	11.76										
1932	16.47	11.80										
1933	16.30	11.63										
1934	12.42	12.25										
1935	12.61	12.44	12.4936	12.4621	18,166,269.11	75.89	18,120,466.66	75.70	18,180,115.18	75.9512	18,189,953.12	75.9923
1936	12.89	12.73										
1937	13.05	12.89										
1938	13.41	13.41										
1939	13.52	13.52										
1940	13.78	13.78	13.6962	13.7138	22,783,697.18	95.18	22,812,974.87	95.31	22,775,243.23	95.1483	22,761,838.75	95.0923
1941	14.01	14.01										
1942	14.05	14.05										
1943	14.06	14.06										
1944	14.23	14.23										
1945	14.56	14.56	14.5274	14.3666	26,879,481.65	112.29	26,581,959.68	111.05	26,867,415.98	112.2442	26,547,862.72	110.9092
1950			15.0865	14.6950	30,316,306.66	126.65	29,529,587.81	123.37	30,318,064.62	126.6600	29,547,306.93	123.4400
1955			15.4562	14.8573	33,057,859.67	138.11	31,776,926.96	132.75	33,067,587.06	138.1467	31,809,049.87	132.8889
1960			15.6980	14.9368	35,135,938.61	146.79	33,432,188.04	139.67	35,135,348.00	146.7852	33,431,590.54	139.6674
1965			15.8549	14.9756	36,630,558.47	153.03	34,599,057.17	144.54	36,619,654.96	152.9862	34,563,120.27	144.3946
1970			15.9564	14.9945	37,659,050.68	157.33	35,388,849.33	147.84	37,697,854.00	157.4906	35,401,403.02	147.8967

#3

#3

1/ Weight tax per vehicle (trend) multiplied by motor vehicle registration (trend).
2/ Actual total weight tax in 1941 ($23,936,573.99) = 100.00

MICHIGAN REGISTRATION OF MOTOR VEHICLES
1905-1970

1920

M C & K F
11 = C

MICHIGAN
STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER
STATE HIGHWAY COMMISSIONER

HUNDRED THOUSAND VEHICLES

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970

ACTUAL

Table A-1

Table A-3

Typed sheet

ESTIMATED (BASED ON PRE-WAR TRENDS)

TREND

POST-WAR ESTIMATE

DOT

TREND EQUATION

$Y = 17.639 + 8.457X - .882X^2 - .0135X^3 + .006X^4$

1941 (1,708,191) = 100.00

	TREND NUMBER OF VEHICLES Y	RATIO
X		
X1945 = -1	1,850,261	108.317
X1950 = 0	2,009,499	117.639
X1955 = 1	2,38,809	125.209
X1960 = 2	2,238,243	131.030
X1965 = 3	2,310,362	135.252
X1970 = 4	2,360,122	138.165

CHART (1)

MICHIGAN
MOTOR FUEL TAX PER MOTOR VEHICLE
1927-1970

TREND EQUATION

$Y = a\,b\,c^X$

$\text{Log } Y = \text{Log } a + \text{Log } b(c^X)$

$\text{Log } Y = 1.3759991 - .2259576\,(.907563)^X$

TREND X	Y
X 1927 = 0	
X 1928 = 1	
X 1929 = 2	
X 1930 = 3	$16.1097
X 1935 = 8	18.7067
X 1940 = 13	20.5099
X 1945 = 18	21.7056
X 1950 = 23	22.4762
X 1955 = 28	22.9642
X 1960 = 33	23.2699
X 1965 = 38	23.4602
X 1970 = 43	23.5782

MICHIGAN
STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER
STATE HIGHWAY COMMISSIONER

MQRF
HSC

DOLLARS

24
23
22
21
20
19
18
17
16
15
14

1925 1930 1935 1940 1945 1950 1955 1960 1965 1970

ACTUAL

TREND

ESTIMATED (Based on pre-war trend)

Table A-A

Table A-A

Post war estimate

CHART (2)

KEUFFEL & ESSER CO., N.Y., NO. 33-41
MADE IN U.S.A.

MICHIGAN MOTOR FUEL TAX RECEIPTS
1928 - 1970

MICHIGAN
STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER
STATE HIGHWAY COMMISSIONER

MILLIONS OF DOLLARS

64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0

1925 1930 1935 1940 1945 1950 1955 1960 1965 1970

ACTUAL

TREND

ESTIMATED (Based on Highway Trends)

Post War Estimate

TREND EQUATION

$Y = 127.327 + 12.68726X - 1.5103811X^2 - .00314293X^3 + .0124157X^4$

1941 ($35,475,346.66) = 100.00

	TREND DOLLARS	RATIO
X 1945 = -1	40,138,545.	113.1449
X 1950 = 0	45,169,694.	127.327
X 1955 = 1	49,138,037.	138.5132
X 1960 = 2	52,089,693.	146.8335
X 1965 = 3	54,176,601.	152.7162
X 1970 = 4	55,656,278.	156.8872

KEUFFEL & ESSER CO., N. Y. NO. 359-11
MADE IN U.S.A.

CHART (3)

MICHIGAN WEIGHT TAX PER MOTOR VEHICLE
1925-1970

MICHIGAN
STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER
STATE HIGHWAY COMMISSIONER

MCRF
HISC

DOLLARS

17
16
15
14
13
12
11
10
9

1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970

Table A-6

Post war Estimate

Table A-6 from Statistical Digest

MAXIMUM TREND ESTIMATED (Based on pre-war trend)

MINIMUM TREND

ACTUAL ADJUSTED TO
1946 RATES

MAXIMUM ESTIMATE
TREND EQUATION
$\text{Log } Y = 1.2078798 - .1451845\,(.914906)^X$
ORIGIN = 1932

TREND

X	Y	
X1930	10.8246	(Extrapolated)
X1935 = 3	12.4936	
X1940 = 8	13.6962	
X1945 = 13	14.5274	
X1950 = 18	15.0865	
X1955 = 23	15.4562	
X1960 = 28	15.6980	
X1965 = 33	15.8549	
X1970 = 38	15.9564	

MINIMUM ESTIMATE
TREND EQUATION
$\text{Log } Y = 1.1764492 - .1079178\,(.865598)^X$
ORIGIN = 1933

TREND

X	Y	
X1930	10.5000	(Extrapolated)
X1935 = 2	12.4621	
X1940 = 7	13.7138	
X1945 = 12	14.3666	
X1950 = 17	14.6950	
X1955 = 22	14.8573	
X1960 = 27	14.9368	
X1965 = 32	14.9756	
X1970 = 37	14.9945	

CHART (4)

MICHIGAN
WEIGHT TAX RECEIPTS
1920-1970

MILLIONS OF DOLLARS

ACTUAL

ADJUSTED TO 1946 RATES

ESTIMATED (Based on Pre-war trends)

MAXIMUM TREND

MINIMUM TREND

Post war estimate

Table A-1

MAXIMUM ESTIMATE

TREND EQUATION

$Y = 126.66 + 12.9653X - 1.4783X^2 - .014019X^3 + .0137476X^4$

1941 ($23,936,773.96) = 100.00

	TREND DOLLARS	RATIO
X1945 = -1	26,867,640.	112.2442
X1950 = 0	30,318,318.	126.66
X1955 = 1	33,067,863.	138.1467
X1960 = 2	35,135,642.	146.7852
X1965 = 3	36,619,961.	152.9862
X1970 = 4	37,698,169	157.4906

MINIMUM ESTIMATE

TREND EQUATION

$Y = 123.44 + 10.9385X - 1.5496X^2 + .05132X^2 + .00864X^4$

	TREND DOLLARS	RATIO
X1945 = -1	26,548,085.	110.9092
X1950 = 0	29,547,554.	123.44
X1955 = 1	31,809,316.	132.8889
X1960 = 2	33,431,870.	139.6674
X1965 = 3	34,563,409.	144.3946
X1970 = 4	35,401,699.	147.8967

MICHIGAN
STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER
STATE HIGHWAY COMMISSIONER

MSHD

CHART(5)