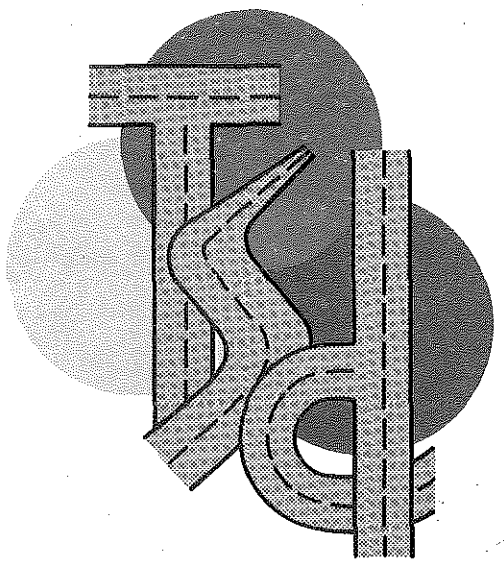
SAFETY ASPECTS OF THE 55-MPH SPEED LIMIT

Report TSD - 295-74



TRAFFIC and SAFETY DIVISION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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ACKNOWLEDGMENT

The researchers thank Messrs. Keith Bushnell and Sharif Shakrani of our Bureau of Transportation Planning for their effort in providing the speed and travel information utilizing the data obtained through their surveys and the economic information which they secured from other agencies. Our appreciation also extends to the American Automobile Association of Michigan; Michigan Departments of Commerce and Treasury; Michigan Liquor Control Commission; Michigan Employment Security Commission; and R. J. Polk Research Center, East Lansing.

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1 - INTRODUCTION

The Governor's office in October 1974 asked the Department of State Highways and Transportation for a report of the effect on highway safety of the 55 MPH speed limit in force since March 1974. The reason for this request was to obtain factual information and the Department's recommendations on the retention or revision of the present speed limit. Other departments of the State were also asked for their reports on matters related to their fields of activity. These reports would help the Governor to formulate by early January 1975 his policy on highway speeds.

The nationally imposed 55 MPH maximum speed limit, implemented as a measure of fuel conservation, has been credited by many as the causative factor in the reduction of fatalities on highways. Others, opposing this limit, have argued that other factors contributed to the decline in accidents, such as reduced volumes, hence less exposure, and general economic conditions directly related to fuel shortage. Also, elimination of roadside hazards, improved car design, use of safety belts, and better emergency and medical facilities would have resulted in reduced fatalities.

The objective of this study was, therefore, to examine all the technical evidence and evaluate the degree of increased highway safety, if any, attained through the lowered speed limit. Our study was initiated independently of other similar studies in the country. Some such studies, either concluded or in progress, that are known to us are those by the American Association of State Highway and Transportation Officials, the National Safety

Council, the Federal Highway Administration, the National Highway Safety Administration, and the University of Michigan Highway Safety Research Institute. The present study is based solely on the accident and speed survey data normally compiled by our Department and some data on economic activity in the State that were readily available from outside sources.

The time available to formulate a study plan, to gain approval for the plan, to compile and analyze the data, and to prepare a report was less than two months. This time limitation precluded an in-depth study, possibly examining other factors such as the effects on accidents of safety belt use, bicycles and motorcycles, car occupancy, trip purposes and lengths, alcohol involvement, etc.

Hypothesizing that freeway accidents might be less sensitive to speed drop than conventional highways, the study was structured to examine these two road systems separately. Further breakdown of the conventional road system, such as two-lane rural roads, four-lane divided and undivided roads were also reviewed individually. A brief description of the procedure follows and the methods of data analysis used will be presented in the following pages. This will be followed by a discussion of the results, conclusions and recommendations.

2 - STUDY PROCEDURES

2.1 - GATHERING OF DATA

The data compiled for this study can be listed in four categories: accidents, highway travel, speeds, and economic factors.

2.1.1 - Accident Data

Accident data for the state trunklines are stored on magnetic tapes in our computer library and can be tabulated using numerous existing programs. Total, injury, and fatal accident data on a monthly basis were retrieved for the thirty-month period from January 1972 through June 1974. Total and injury accident data for the City of Detroit are not included in this study; however, fatal accidents are. The data were tabulated by freeway and conventional road systems. Further classification of the conventional road accidents was made by the following types: two-lane rural roads, three- and four-lane non-divided rural roads, four-lane divided roads, total rural roads, and total urban roads. Accidents were also listed by week-day/week-end, day/night, and single-vehicle/multiple-vehicle types.

Accident rates per hundred million vehicle miles were calculated based on travel information mentioned in the next section. Rates of total, injury, and fatal accidents were tabulated by freeway and conventional road categories.

2.1.2 - Highway Travel

Highway travel in vehicle miles was estimated by months for the 30-month period by our Bureau of Transportation Planning based on traffic volume counts and fuel use, as normally done. The information included figures for all the roads in the State including county and city systems, for freeways, and for conventional state trunklines.

2.1.3 - Highway Speeds

The Department conducts speed surveys on a quarterly basis each year. These surveys are intended to reflect the Winter (January), Spring (April), Summer (July), and Fall (October) speed characteristics of vehicle operators on the Michigan trunkline system. Individual surveys are taken quarterly on the various types of highways. There are 25 rural stations and one urban station throughout the State. A few of the stations are on county roads.

Speed data used in this study consisted of average speeds, 85th percentile speeds (speed which 85 percent of the traffic does not exceed), and the standard deviation(which is a measure of the variation of the individual speeds measured at each station). The data for the 26 stations were averaged under the following road types: two-lane roads, three- and four-lane undivided roads, four-lane divided free access roads with the blanket speed limit (65 MPH before and 55 MPH after March 1974), a five-lane (center lane for left turns) urban road with 40 MPH limit, and freeways. The data spanned the period from January 1972 through October 1974. Average speeds for trucks and passenger

cars were also reviewed.

2.1.4 - Economic Factors

Data compiled as economic indicators for Michigan were gasoline and diesel fuel used, average price of gasoline, sales tax receipts, consumer price index, sales tax adjusted by consumer price index, liquor sales, new cars sold by size categories, total labor force, and percent of employment. The figures were on a monthly basis for the 30-month study period.

The economic data other than motor fuel used were obtained from sources outside the Department. Average gasoline price was obtained from the American Automobile Association of Michigan. Reliable information on gas station business hours was unavailable. Michigan's share of the gross national product was also unavailable. Sales tax information was obtained from the Department of Treasury. Consumer price index with 1967 as the base year was that of the United States which closely agreed with the Michigan price index. The source of this data was the Michigan Department of Commerce. Liquor sales were obtained from the Michigan Liquor Control Commission. The source of car sale data was R. J. Polk Research Center in East Lansing. Total labor force and percent of employment were taken from the Michigan Employment Security Commission.

Numerical data are not reproduced in this report, but are kept in the study file.

2.2 - ANALYSIS OF DATA

Data analysis followed three general procedures. As a preliminary overview, numerous data were selected for graphical analysis. For this analysis, all data were reduced to index figures based on January 1972 values taken as 100. Trends in these graphs, individually and in comparison with each other, were examined and discussed at some length by the researchers at several sessions.

A second analysis approach used cumulative values for the travel, accidents, and some basic economic data for two seven-month periods and compared the degree of change between the two periods.

The third method of analysis involved statistical studies of multiple linear regression. These examined the degree of correlation between accidents and travel, average speed, percentage of employment, liquor sales, sales tax, motor fuel use, and car sales during the 30-month study period.

The analysis procedures will be only briefly described in the following sections to make this report as concise as possible without omitting the essential phases of the study.

2.2.1 - Graphical Analysis

All selected data were plotted using months as the horizontal coordinate and index values as the vertical. Each chart contained either two or three graphs, resulting in a total of 96 graphs. The Appendix includes some of the most significant

information shown in graphical form with absolute values rather than the indices used in the preliminary analysis.

Four dates are indicated on each of these graphs by vertical dashed lines. The first line is for October 1973 which is the start of the Arab oil embargo. The second is for November 1973 when the President of the United States urged the nation to drive under 50 MPH. The third is for March 1974 when Michigan started to enforce the 55 MPH limit and the fourth is for April 1974 when the Middle East oil embargo ended.

The most significant observation from a review, comparison, and superimposition of the various charts was the general downward trend in all types of accidents after the Fall of 1973 although travel graphs indicated only a slight drop in miles traveled. The speed trends indicated a similar drop long before the legal speed limit was reduced to 55 MPH. Average and 85th percentile speeds on those roads where the speed limits were always less than 55 also showed a downward trend after Fall of 1973. Speeds on all highways started to climb upward during the second quarter of 1974. Standard deviations of speed decreased noticeably after January 1974 but started to increase on most road categories after April. Monthly accident experience peaked in December of each year with corresponding peaks in sales tax collected and very sharp peaks in liquor sales. No other significant deductions could be made from the graphs for the specific purposes of this study.

2.2.2 - Comparison of Two Time Periods

Considering the seven-month period of the Middle East oil embargo, October 1973 through April 1974, as the critical period which caused abrupt changes in the characteristics of highway traffic, cumulative data for this period were compared with the corresponding period of the previous year, i.e., October 1972 through April 1973. The result is shown in Table 1. Travel on the conventional state trunkline (other than freeways) dropped 4.8 percent during the critical period. Total accident experience on this road system decreased 12.8 percent. This decrease was 17.2 percent in injury accidents and 30.0 percent in fatal accidents. On the rural portions of the same road system, total accidents decreased 15.4 percent and the injury and fatal crashes by 18.5 and 26.6 percent, respectively. The urban segments of this system showed lesser decreases in the total and injury accidents but a very high drop of 39.0 percent in fatals.

A parallel analysis for the freeway system revealed a greater drop (6.3%) in travel on this system than the conventional roads. Percentage of reduction in total and injury accidents were larger (almost 20%) but in fatals it was smaller (17.0%) than the other system. Urban and rural breakdown of freeway accidents can also be seen in Table 1. It should be noted, however, that total and injury accidents within the City of Detroit are not included but the fatal accidents are included

TABLE 1

COMPARISON OF TRAVEL, ACCIDENTS, AND ECONOMIC INDICATORS DURING THE CRITICAL PERIOD WITH THE CORRESPONDING PERIOD OF PREVIOUS YEAR

	OCT.'72 THRU APR.'73	OCT.'73 THRU APR.'74	% CHANGE
TRAVEL ON ALL CONVENTIONAL STATE TRUNKLINES (THOUSAND VEH. MI.)	8,894.740	8,466.522	- 4.8
ACCIDENTS ON CONVENTIONAL T.L.'s			
TOTAL	53,880	46,964	-12.8
INJURY	14,976	12,405	-17.2
FATAL	363	254	-30.0
ACCIDENTS ON RURAL CONVEN. T.L.'s			
TOTAL	23,458	19,856	-15.4
INJURY	6,801	5,540	-18.5
FATAL	263	193	-26.6
ACCIDENTS ON URBAN CONVEN. T.L.'s			
TOTAL	30,422	27,108	-10.9
INJURY	8,175	6,865	-16.0
FATAL	100	61	-39.0

TABLE 1 - Continued

	OCT.'72 THRU APR.'73	OCT.'73 THRU APR.'74	% CHANGE
TOTAL FREEWAY TRAVEL (THOUSAND VEH. MI.)	6,398,558	5,994,332	- 6.3
FREEWAY ACCIDENTS:			
TOTAL	11,518	9,255	-19.7
INJURY	3,338	2,684	-19.6
FATAL	118	98	-17.0
RURAL FREEWAY ACCIDENTS:			
TOTAL	7,071	5,521	-21.9
INJURY	2,003	1,519	-24.2
FATAL	81	59	-27.2
URBAN FREEWAY ACCIDENTS:			
TOTAL	4,447	3,734	-16.0
INJURY	1,385	1,165	-15.9
FATAL	37	39	+ 5.4
SALES TAX ADJUSTED BY C.P.I. ($1,000)	543,832	535,534	- 1.5
NO. NEW CARS SOLD	400,811	328,764	-18.0

TABLE 2

RATIO OF INJURY ACCIDENTS TO FATAL ACCIDENTS

BEFORE AND DURING THE CRITICAL PERIOD

	Oct.'72 thru Apr.'73	Oct.'73 thru Apr.'74
All Conventional Roads	41.3	48.8
Rural Conventional Roads	25.9	28.7
Urban Conventional Roads	81.7	112.5
All Freeways	28.3	27.4
Rural Freeways	24.7	25.8
Urban Freeways	37.4	29.9

in the urban data. Fatal crashes on urban freeways is the only item in the whole analysis that shows a gain, which is 5.4 percent. However, the small size of the numbers involved would rule this gain insignificant.

Sales tax adjusted by the consumer price index and number of new cars sold are also shown in Table 1. These data may be interpreted as an indication of a very minor recession of 1.5 percent in the general economic activity of the State but a sharp decline of 18 percent in the automotive sector of the economy.

Table 2 shows the ratios of injury accidents to fatal accidents for the two comparative periods. In general, a slight improvement in fatalities is observed except for the case of urban freeways which also adversely affect the record of all freeways.

2.2.3 - Statistical Analysis

In the multiple linear regression analysis used, the monthly number of accidents in the study period was assumed to be normally distributed, with the mean as a linear function of the seven independent variables and with constant variance.

Table A in the Appendix, depicting the Analysis, includes the predicted equations, coefficient of determination of R^2, F test of regression coefficients, partial correlation coefficients, and the overall F test in eight different accident classifications and related variables as shown in the subtitles of the table. The following Table 3 is an excerpt from those results.

	FREEWAY TOTAL ACCIDENTS FREEWAY VEH.-MILES FREEWAY DAYTIME AVERAGE SPEED	CONV. RD. TOTAL ACCIDENTS CONV. ROAD VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED	FREEWAY FATAL ACCIDENTS FREEWAY VEH.-MILES FREEWAY DAYTIME AVERAGE SPEED	CONV. RD. FATAL ACC. CONV. ROAD VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED
PREDICTED EQUATION (A) y NUMBER OF ACCIDENTS x_1 VEHICLE - MILES (1000) x_2 AVERAGE SPEED (MPH) x_3 PERCENTAGE OF EMPLOYMENT x_4 LIQUOR SALES($1000) x_5 SALES TAX ($1000) x_6 MOTOR FUEL USE (million gal.) x_7 CAR SALES (unit)	$y = -3560.99 - 0.00000885x_1 + 53.1819x_2 + 18.0992x_3 + 0.0418x_4 - 0.0335x_5 + 0.0024x_6 + 0.0034x_7$	$y = -20292.7991 + 0.0008x_1 + 140.0158x_2 + 210.1344x_3 + 0.1277x_4 - 0.0941x_5 + 0.0032x_6 + 0.0140x_7$	$y = -45.0882 + 0.00000766x_1 + 0.5451x_2 + 0.1098x_3 + 0.0000265x_4 + 0.0000685x_5 + 0.000010155x_6 - 0.00003798x_7$	$y = -58.4972 + 0.000023343x_1 + 2.3198x_2 - 0.8963x_3 + 0.0004x_4 - 0.0006x_5 + 0.000072296x_6 + 0.0005x_7$
COEFFICIENT OF DETERMINATION (ADJ) R^2 (B)	48.5 %	59.0 %	10.1%	77.3%
SQUARE OF PARTIAL CORRELATION COEFFICIENT r^2 (C)	1. SPEED 24.9% 2. LIQUOR SALES 23.3% 3. SALES TAX 14.4%	1. LIQUOR SALES 30.3% 2. SPEED 18.2% 3. SALES TAX 17.2% 4. EMPLOYMENT 15.5%	1. SPEED 8.1%	1. SPEED 38.1% 2. CAR SALES 28.0% 3. VEH-MILES 27.2%

NOTES: (A) Least square method for the best fit linear equation.

(B) Indicates the proportion of the variation in the dependent variable which has been mathematically accounted for; whereas $1-R^2$ indicates the proportion which has not been accounted for.

(C) Measures the importance of each variable after all the other variables are taken into account.

TABLE 3: SUMMARY OF REGRESSION ANALYSIS.

Significant association with the chosen factors is indicated in the freeway and conventional-road total accidents. Average speed had the highest percentage of association with the freeway total accidents, liquor sales ranked second, and sales tax third. Liquor sales ranked first with the conventional-road accidents, average speed second, and sales tax third. The concept of association of events should not be confused with the idea of causation. Assocation, as used in statistics, means that the events are not independent. Association may be a consequence of causation but this need not be true.

Freeway fatal accidents show no significant correlation with the other factors in the model, but conventional-road fatal accidents appeared to be highly correlated, average speed ranking first, car sales second, and vehicle miles of travel third.

The coefficients for average speed in the predicted equations indicate that each mile-per-hour increase in freeway speed would increase total accidents by 53.2 per month. On conventional roads this increase would be 140. Also, on conventional roads each MPH increase would cause 2.3 fatal accidents per month.

3 - DISCUSSION OF RESULTS

Any attempt to define the effect on highway safety of the 55 MPH speed limit is far from being precise. The prediction formulas that were derived in this study define the sensitivity of accident variation to speed change and other variables. However, the variation in speeds has not been defined as a direct function of the 55 MPH speed limit. The judgment of the driver, somewhat modified by the degree of speed-law enforcement, is the accepted fundamental factor in the resulting highway speeds.

Lower and more uniform travel speeds during the gasoline shortage resulted in considerable reduction in total, injury, and fatal accidents. Although the 55 MPH speed limit had an effect on this change in speed characteristics and on accident causation, this limit alone will not continue to hold speeds and accidents down in the future if gasoline is abundantly available. The present trend, since the end of the Middle East oil embargo, is for the speeds and accident rates to gradually rise again. The real effectiveness of the present speed limit to keep travel speeds and accidents down can only be determined by continuing surveys and studies.

Traffic engineers and enforcement officers have recognized that any speed limit which, in the opinion of the majority of drivers, is unreasonable is not enforceable. The design of vehicles and highways has been developed through the decades with high speed as a main objective. Given these basic conditions the public

will not adhere to low speed limits. Obviously, if the speed were reduced to as low as 10 MPH fatal accidents would be reduced to practically zero, but modern society would not tolerate this condition. Highway speeds and resulting accidents are a matter of trade-off between good (mobility) and evil (accidents). A reasonable compromise selected by an informed society should eventually prevail.

Accident and fatality rates are lower on freeways than conventional roads, as indicated on Figures 5 and 6 in the Appendix. A percentage of reduction applied to freeways would therefore be less productive as compared with conventional highways.

As mentioned under the Statistical Analysis section, the mathematical model used shows that each mile-per-hour change in speeds as surveyed would result in a change of 140 total accidents per month on conventional roads and 53.2, or only about a third, on freeways. This does not mean that each mile-per-hour speed change in the legal speed limit will necessarily result in the same amount of change in accidents; however, it is probably an indication of the relative impact of the speed limit on the two highway categories. This lends some support to raising the speed limit on freeways to perhaps 60 MPH and maintaining the speed limit at 55 MPH for conventional roads.

Noted below are some observations derived from the tabulations of data gathered for this study.

Average speeds began dropping in October 1973 at the beginning of the oil embargo. The average speed receded below the 55 MPH limit only on two-lane roads and not on freeways nor on four-lane divided free access roads with the imposed blanket speed limits.

Vehicle miles of travel decreased only slightly throughout the study period. However, the constant growth pattern so evident in the past was missing.

Total accident rates and injury accident rates decreased only slightly for both freeways and conventional roads, whereas fatal accident rates show a significant decrease for conventional roads.

A slight reduction in the ratios of fatal accidents to injuries, except for urban freeways, was noted. This may have been caused partly by reduced speeds. However, other factors such as Michigan's program for Safety Provision for Roadside Features, improved car design, increased use of safety belts, and better emergency and medical facilities may also have played a role.

Despite complaints heard from the driving public about some trucks exceeding the legal speed limit, the speed surveys show that average truck speeds were not above the average passenger car speeds. Trucks were not legally allowed to travel on free access roads above 50 MPH even before the new speed law.

Liquor sales, average speed, and sales tax were highly associated with the change in the total number of accidents on freeways and conventional roads according to the regression analysis. Vehicle miles of travel, which is generally accepted as the measure of exposure to accidents, failed to correlate with the variations in accidents. This was probably due to the small range over which vehicle miles of travel varied during the study period. Freeway fatal accidents in Michigan, which ranged from a low of six in March 1974 to a high of 27 in July 1973, showed little association with any of the seven chosen factors.

4 - CONCLUSIONS

1. Comparing the 7-month period of the Fuel Crisis (Oc 1973 through April 1974) with the 7-month period of year earlier, travel on conventional trunklines decreased by 4.8 percent. Total, injury, and fatal accidents decreased by 12.8, 17.2, and 30.0 percent, respectively.

2. For freeways, travel decreased by 6.3 percent with total, injury, and fatal accidents decreasing by 19.7, 19.6, and 17.0 percent, respectively.

3. During this period, 85th percentile freeway speeds steadily decreased from 73 MPH (just prior to the oil embargo) to 63 MPH (end of oil embargo). From the end of the embargo to October 1974, the speed has gradually increased to about 65 MPH.

4. For two-lane high speed conventional highways, 85th percentile daytime speeds steadily decreased from approximately 66 to 59 MPH during the oil embargo. Since the end of the embargo they have increased to about 60 MPH.

5. For four-lane divided high speed conventional highways, 85th percentile daytime speeds steadily decreased from approximately 70 to 62 MPH during the oil embargo. Since the end of the embargo they have increased to about 63 MPH.

6. The data indicate that the greatest decrease in the 85th percentile speed occurred prior to the time that the 55 MPH speed limit took effect but after the President of the

United States urged the nation to drive under 50 MPH. It appears that the greatest reduction in speed resulted from a short-term change in driver attitude due to factors (availability of fuel, response to President's appeal to conserve fuel, etc.) other than the lowering of the speed limit to 55 MPH.

7. Statistical analysis of accident data for the 30-month period (January 1972 through June 1974) indicates that there is a relationship between average speed of travel for a particular roadway system and total and fatal accidents. This relationship indicates that conventional highways are more sensitive to speed changes in terms of accidents than are freeways.

5 - SUMMARY AND RECOMMENDATION

While there was a significant drop in speed and in total, injury, and fatal accidents during the recent fuel energy crisis (October 1973 through April 1974), accidents and fatalities have tended to increase as have speeds since the end of the fuel shortage. This increase is in spite of the 55 MPH speed limit which went into effect in March 1974. Since March, 85th percentile freeway speeds have increased from 63 to about 65 MPH.

From a traffic engineering viewpoint there is some justification for increasing the 55 MPH speed limit on our freeway system. Traffic engineers and enforcement officers recognize that the ideal speed limit is the one that the majority of drivers will adhere to - generally considered the 85th percentile. The present 85th percentile speed for our freeways is 65 MPH - 10 MPH over the legal speed limit. Also highway speeds and resulting accidents are a matter of trade-off between good (mobility) and bad (accidents) and only an informed society can arrive at a reasonable compromise. However, when considering other important aspects of the 55 MPH speed limit such as the nation's commitment to conserve fuel and the national AASHTO policy to support the existing 55 MPH speed limit until energy conservation is no longer a high priority national concern, it is recommended that Michigan maintain the 55 MPH speed limit subject to further observation and analysis of speed and accident trends. If these trends indicate that in the future selected changes in speed limits are appropriate, recommendations will be made at that time.

APPENDIX

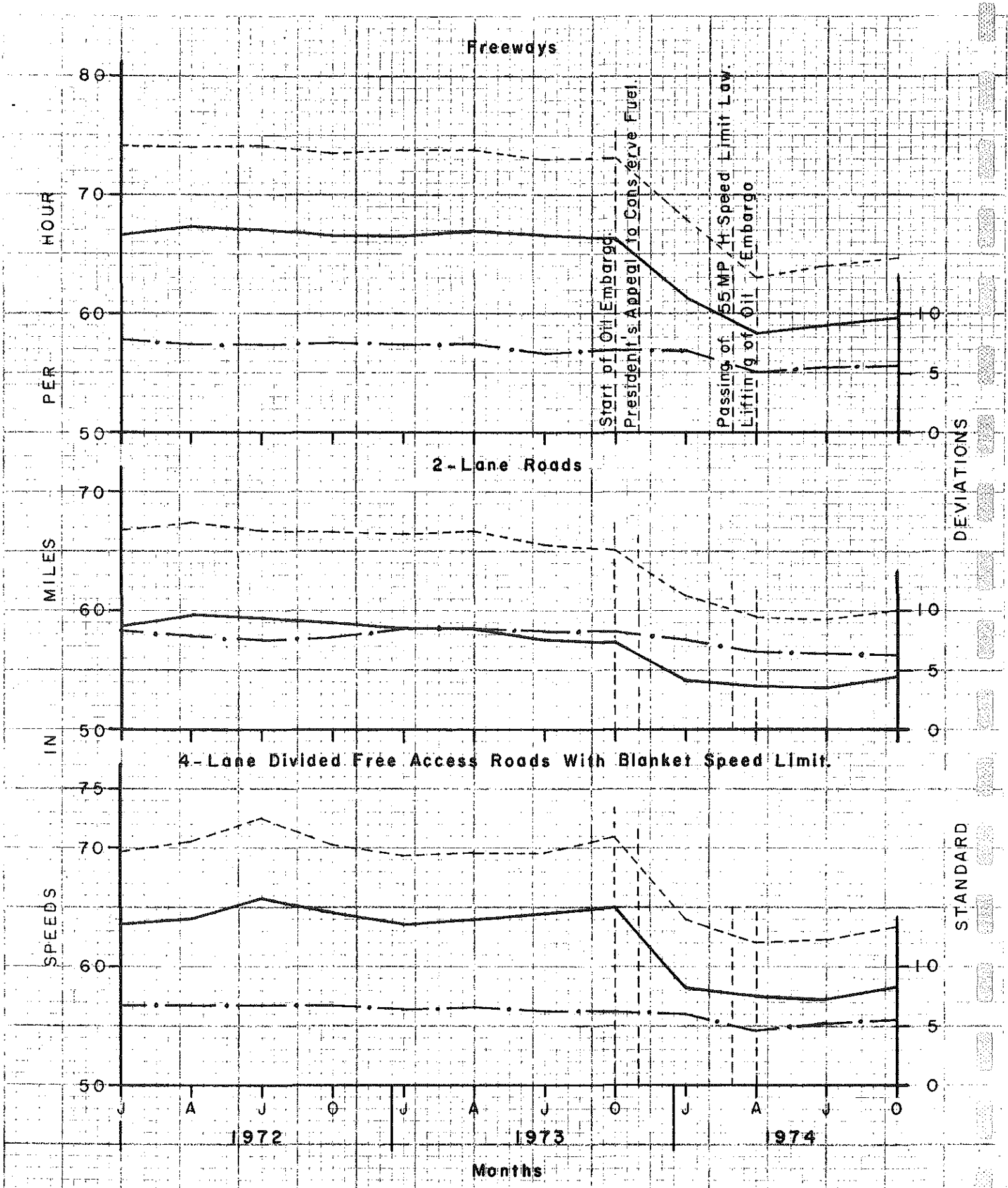

Fig. 1: SPEEDS ON HIGHWAYS WITH BLANKET SPEED LIMITS.

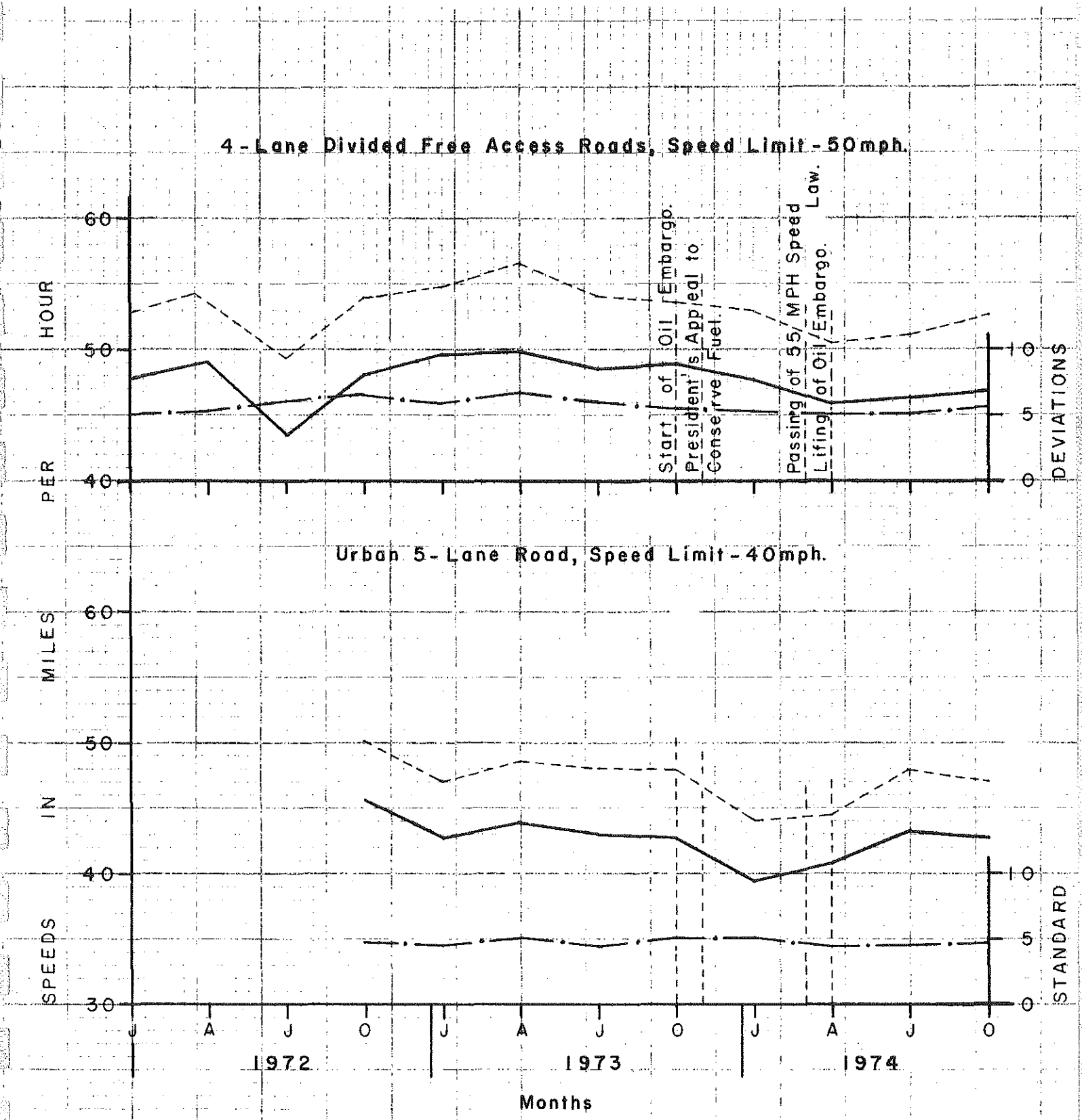

Fig. 2: SPEEDS ON ROADS WITH LOW SPEED LIMITS.

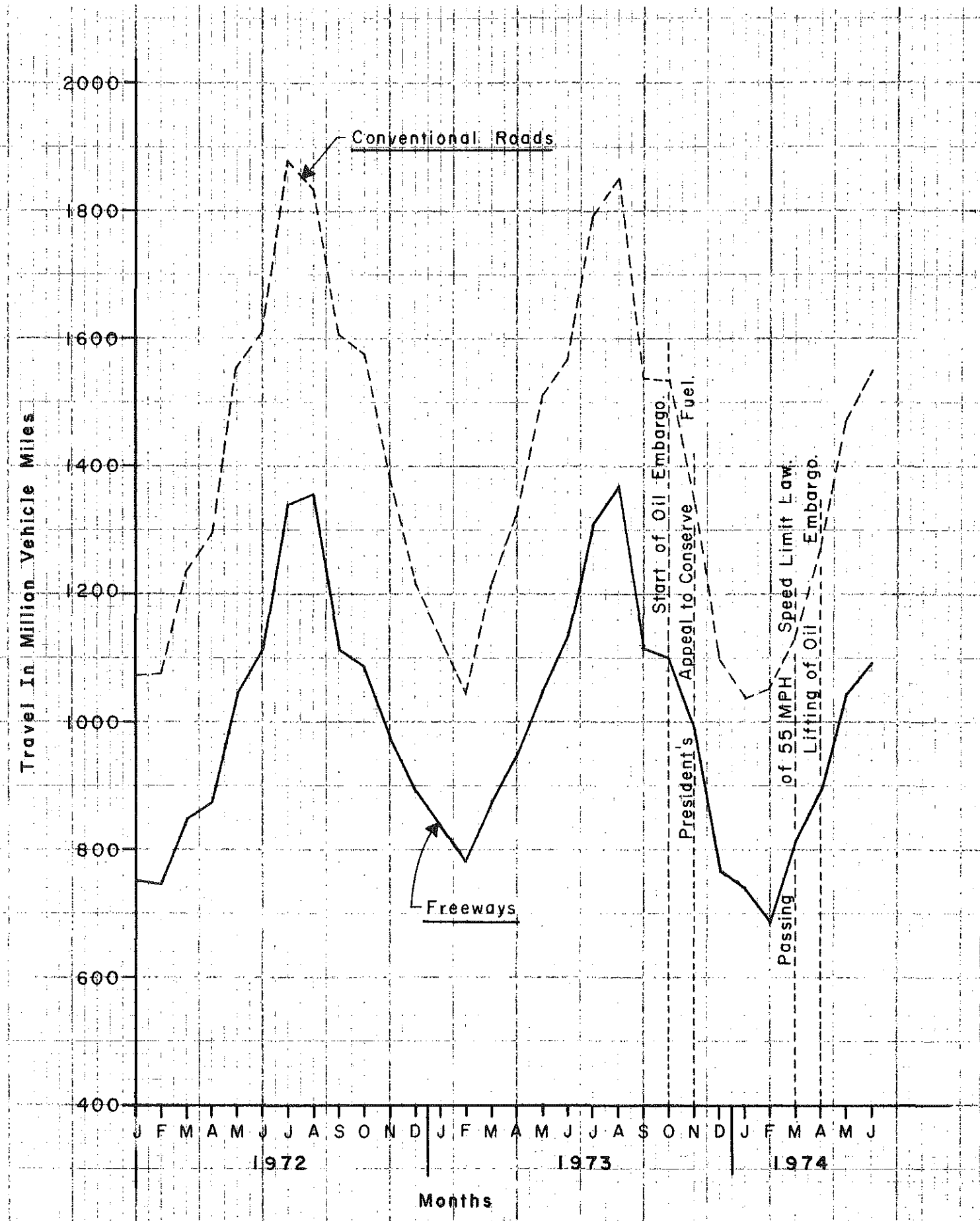

Fig. 3: VEHICLE MILES OF TRAVEL ON STATE TRUNKLINES

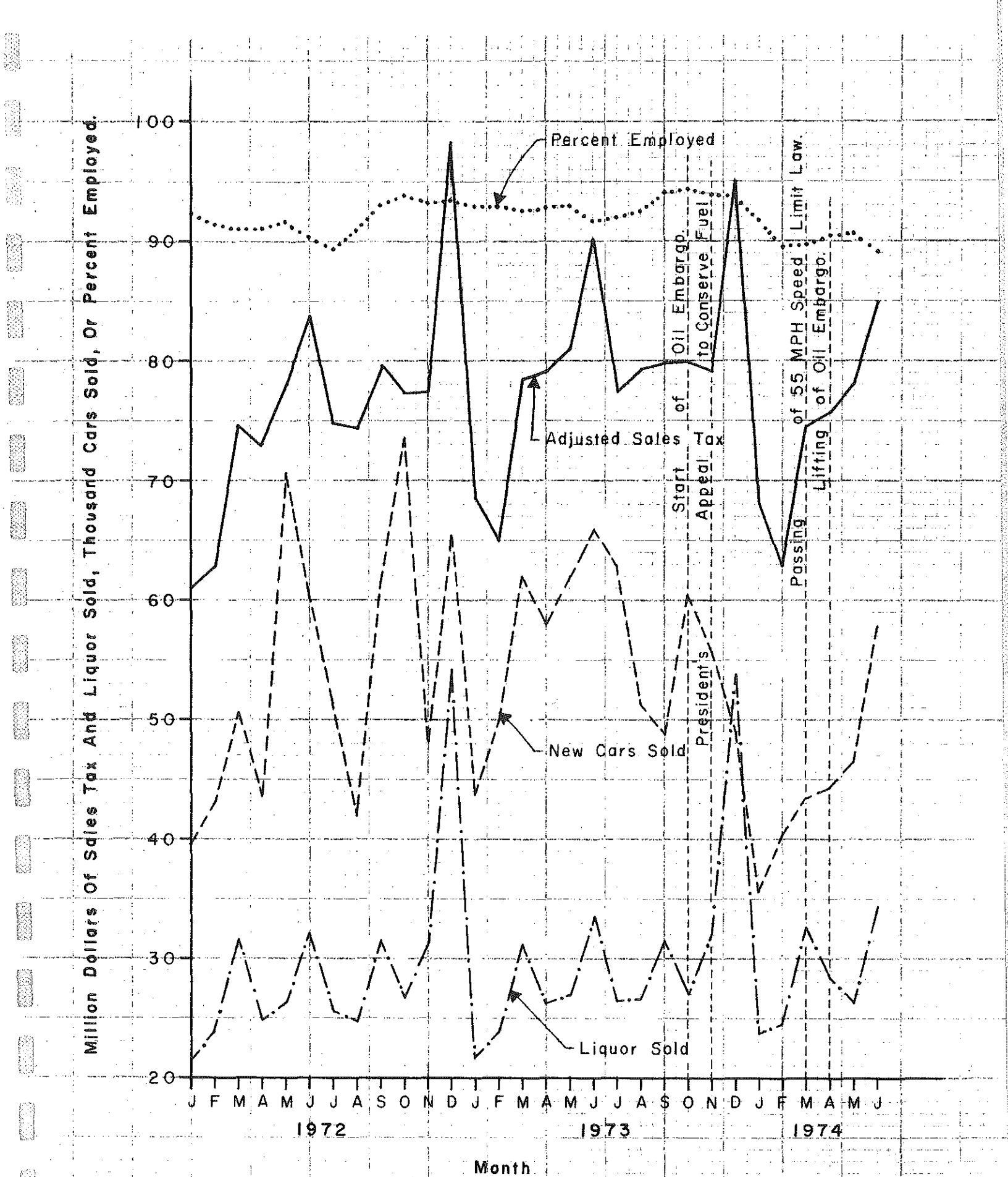

Fig. 4 ECONOMIC INDICATORS FOR MICHIGAN.

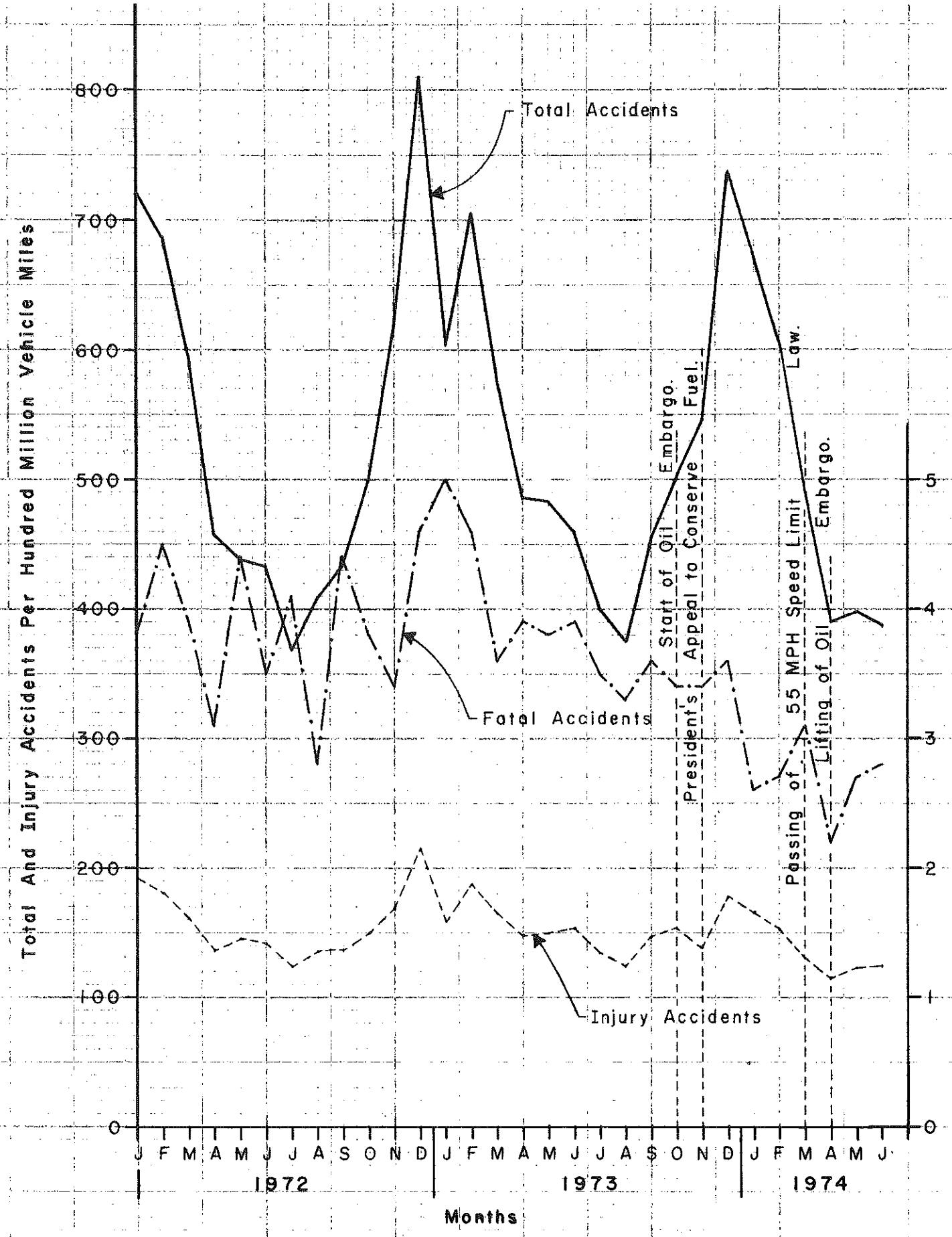

Fig. 5: ACCIDENT RATES ON CONVENTIONAL STATE TRUNKLINES

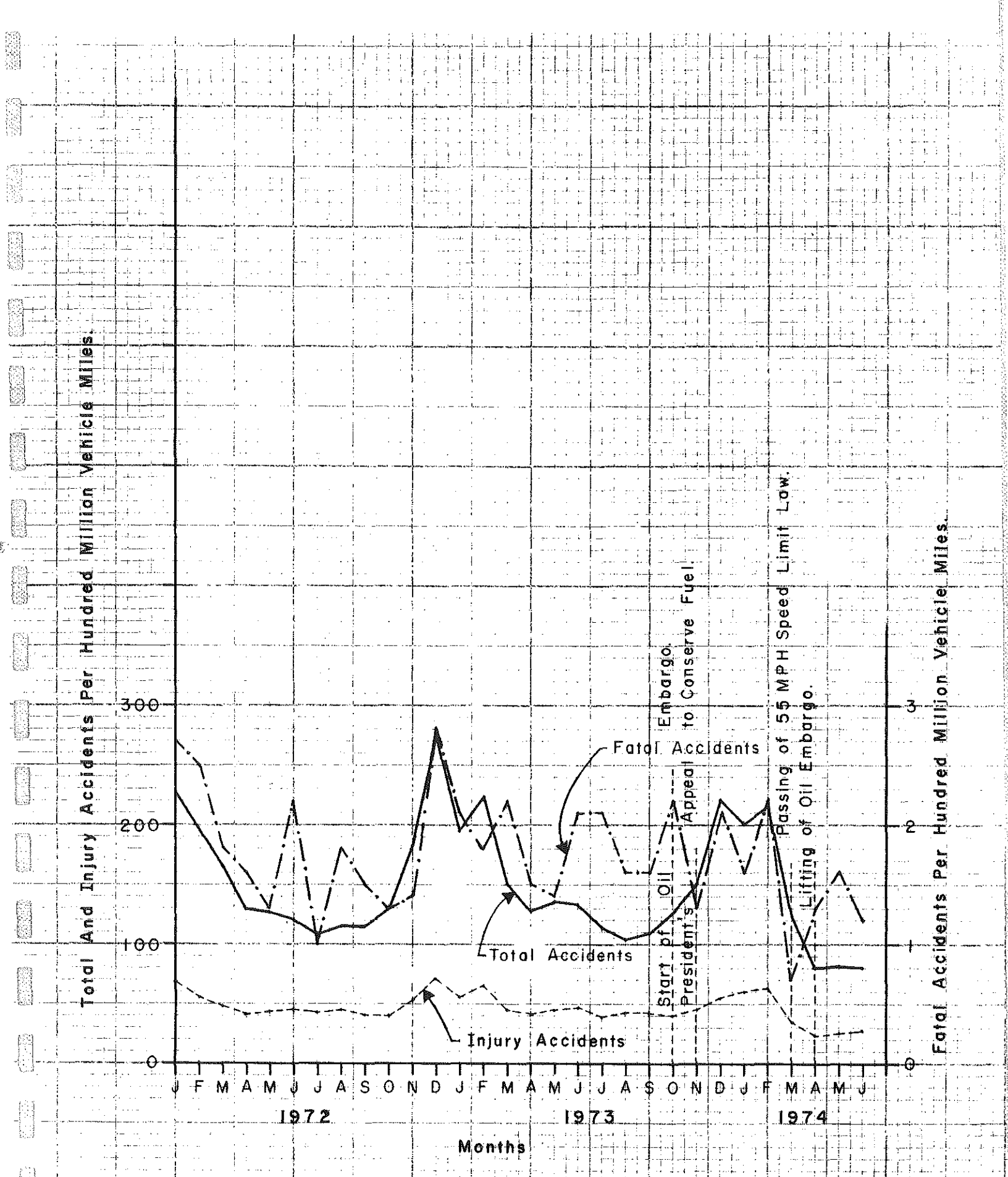

Fig. 6 : ACCIDENT RATES ON FREEWAYS

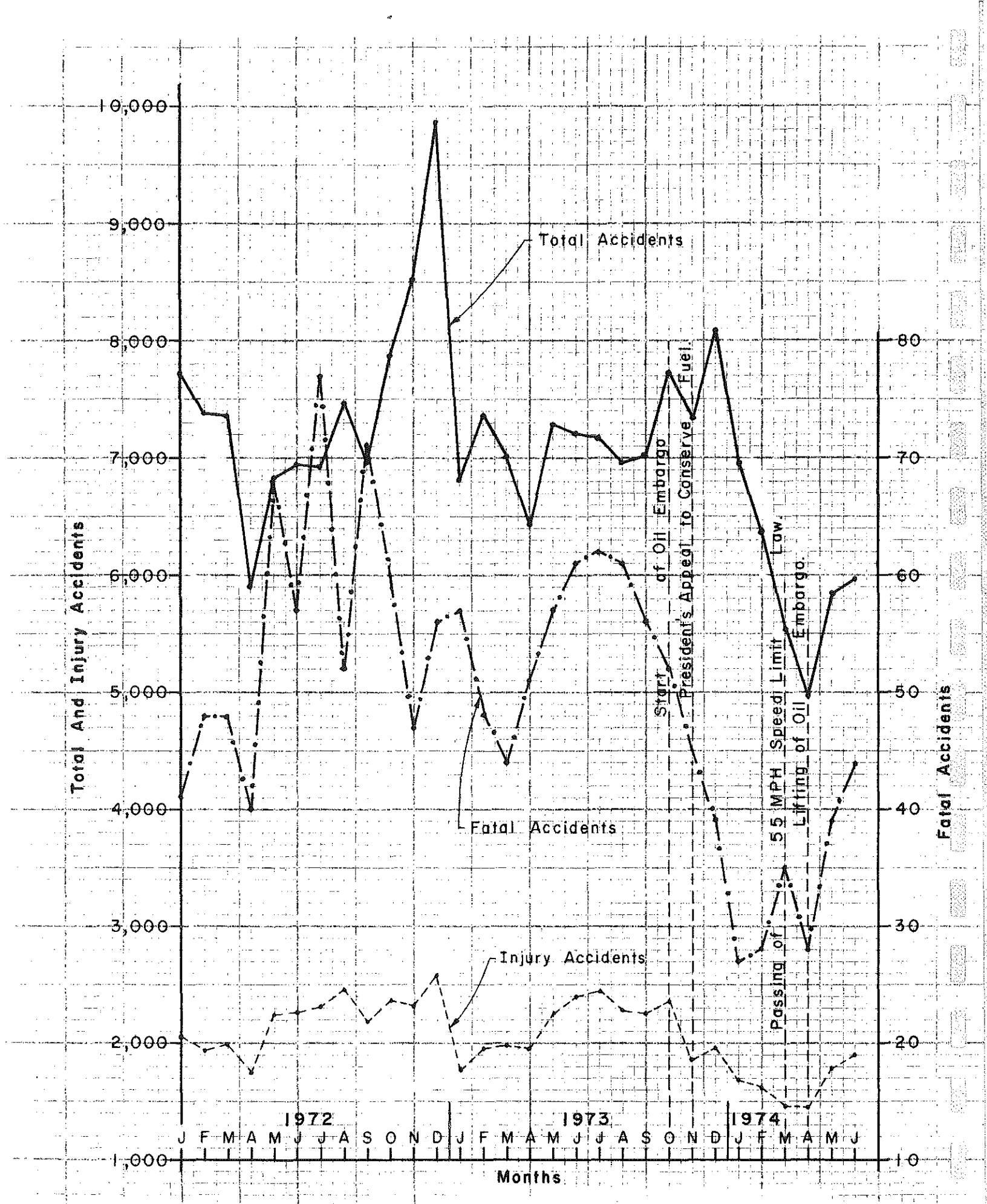

Fig. 7 : ACCIDENTS ON CONVENTIONAL STATE TRUNKLINES.

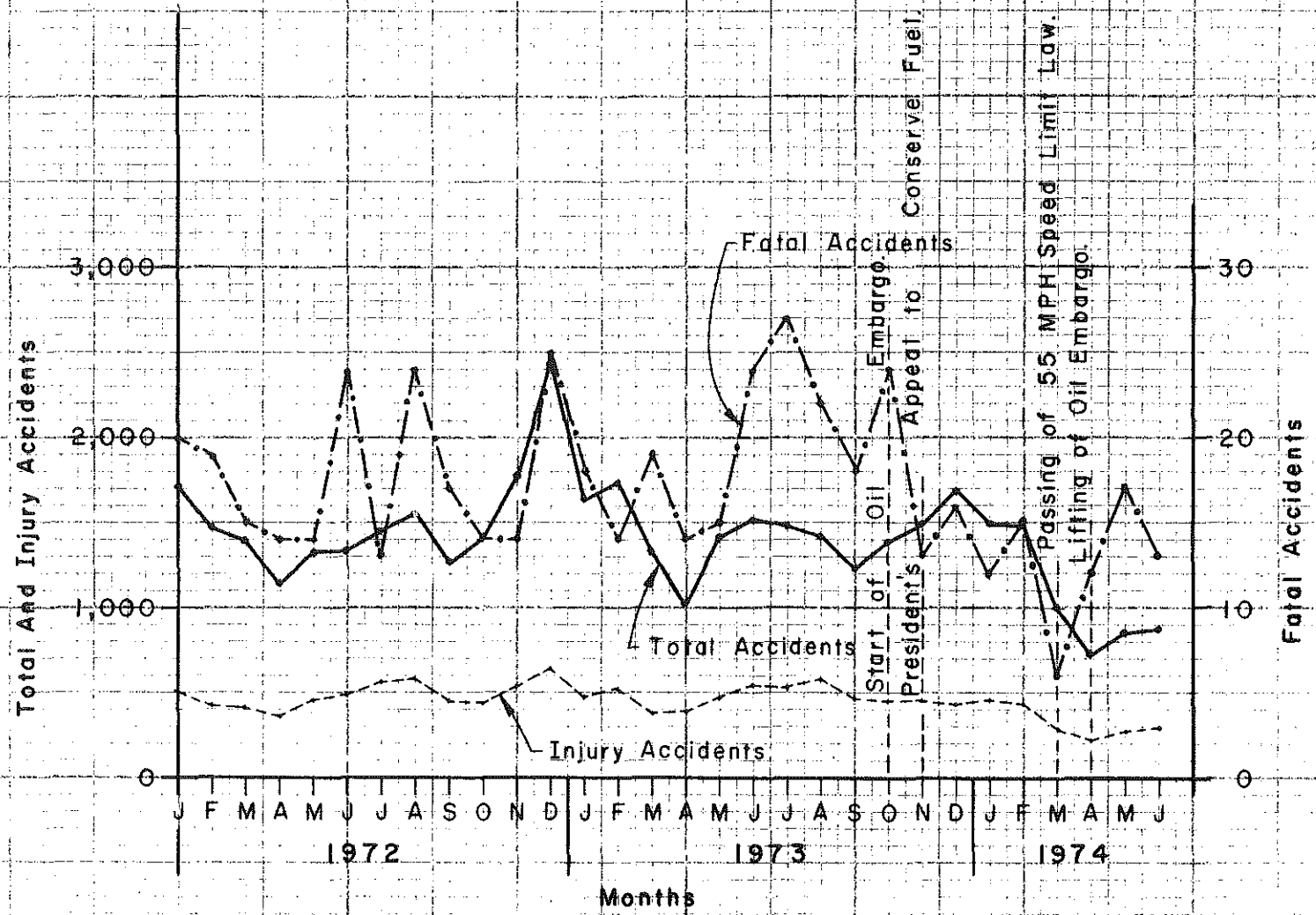

Fig. 8 : ACCIDENTS ON FREEWAYS.

	TRUNKLINE TOTAL ACC. TRUNKLINE VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED	FREEWAY TOTAL ACCIDENTS FREEWAY VEH.-MILES FREEWAY DAYTIME AVERAGE SPEED	CONV RD TOTAL ACCIDENTS CONV. ROAD VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED	URBAN CONV. RD TOT. ACC. CONV. ROAD VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED	TRUNKLINE FATAL ACC TRUNKLINE VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED	FREEWAY FATAL ACCIDENTS FREEWAY VEH.-MILES FREEWAY DAYTIME AVERAGE SPEED	CONV. RD. FATAL ACC. CONV. ROAD VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED	URBAN CONV. RD. FATAL ACCIDENTS CONV. ROAD VEH.-MILES TRUNKLINE DAYTIME AVERAGE SPEED
PREDICTED EQUATION y NUMBER OF ACCIDENTS x_1 VEHICLE - MILES (1000) x_2 AVERAGE SPEED (MPH) x_3 PERCENTAGE OF EMPLOYMENT x_4 LIQUOR SALES($1000) x_5 SALES TAX ($1000) x_6 MOTOR FUEL USE (million gal.) x_7 CAR SALES (unit)	$y = -24423.3115 + 0.0005x_1 + 207.2336x_2 + 229.5615x_3 + 0.17x_4 - 0.1288x_5 + 0.0057x_6 + 0.0178x_7$	$y = -3560.99 - 0.00000885x_1 + 53.1819x_2 + 18.0992x_3 + 0.0418x_4 - 0.0335x_5 + 0.0024x_6 + 0.0034x_7$	$y = -20292.7991 + 0.0008x_1 + 140.0158x_2 + 210.1344x_3 + 0.1277x_4 - 0.0941x_5 + 0.0032x_6 + 0.0140x_7$	$y = -8516.2721 + 0.003x_1 + 687334x_2 + 102.6663x_3 + 0.0668x_4 - 0.0475x_5 - 0.0001x_6 + 0.0052x_7$	$y = -105.6129 + 0.0000166x_1 + 2.9850x_2 - 0.7974x_3 + 0.0005x_4 - 0.0006x_5 + 0.0000836x_6 + 0.0005x_7$	$y = -45.0882 + 0.00000766x_1 + 0.5451x_2 + 0.1098x_3 + 0.0000265x_4 + 0.0000685x_5 + 0.0000101.55x_6 - 0.00003798x_7$	$y = -58.4972 + 0.000023343x_1 + 2.3198x_2 - 0.8963x_3 + 0.0004x_4 - 0.0006x_5 + 0.000072296x_6 + 0.0005x_7$	$y = 43.346 + 0.0000023126x_1 + 0.7195x_2 - 1.0703x_3 + 0.000090786x_4 + 0.0000199x_5 + 0.00002657x_6 + 0.0002x_7$
COEFFICIENT OF DETERMINATION (ADJ) R^2	57.6 %	48.5 %	59.0 %	49.1 %	78.6 %	10.1 %	77.3 %	34.6 %
F-TEST OF REGRESSION COEFFICIENT $F_{.05}(1,28) = 4.20$	1. LIQUOR SALES 9.34 2 SPEED 5.96 3 SALES TAX 4.70	1 SPEED 7.30 2 LIQUOR SALES 6.68 3 SALES TAX 3.70	1. LIQUOR SALES 9.55 2. SPEED 4.90 3 SALES TAX 4.58 4 EMPLOYMENT 4.05	1. LIQUOR SALES 7.90 2 SPEED 3.57 3 SALES TAX 3.52	1 SPEED 16.40 2 VEH - MILES 9.35 3 CAR SALES 5.74	1. SPEED 1.93 (NOT SIGNIFICANT)	1. SPEED 13.51 2 CAR SALES 8.55 3 VEH-MILES 8.24	1. SPEED 3.55 2. EMPLOYMENT 2.88
SQUARE OF PARTIAL CORRELATION COEFFICIENT r^2	1. LIQUOR SALES 29.8% 2. SPEED 21.3% 3. SALES TAX 17.6%	1 SPEED 24.9% 2. LIQUOR SALES 23.3% 3. SALES TAX 14.4%	1 LIQUOR SALES 30.3% 2 SPEED 18.2% 3 SALES TAX 17.2% 4. EMPLOYMENT 15.5%	1 LIQUOR SALES 26.4% 2 SPEED 14.0% 3 SALES TAX 13.8%	1 SPEED 42.8% 2 VEH - MILES 29.8% 3. CAR SALES 20.7%	1 SPEED 8.1%	1. SPEED 38.1% 2. CAR SALES 28.0% 3. VEH-MILES 27.2%	1. SPEED 13.9% 2. EMPLOYMENT 11.6%
$F_{.05}(7,23) = 2.44$ F - TEST OF MULTIPLE REG. (CONFIDENCE LEVEL)	6.63 (99.97%)	4.91 (99.81%)	6.67 (99.98%)	4.99 (99.83%)	16.24 (100.00%)	1.47 (77.00%)	15.13 (100.00%)	3.19 (98.26%)

TABLE A — MULTIPLE LINEAR REGRESSION ANALYSIS.