Filtering of Fatal-Accident Rates

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The relationship between the economy and national fatal-accident rates on a per-vehicle basis is analyzed. Although the relationship is obscured by the strong downward trend in the accident-rate data, there are consistencies apparent in the data. Accident rates historically (1949 to 1973) have decreased during recession periods and increased or changed in rate of decrease after each recession period. Of the specific economic measures studied, national unemployment rates showed the highest correlation (r = 0.86) with fatal-accident rates that were adjusted for the downward trend. Because the performance of the economy seems to have an effect on fatal-accident rates, it may be hazardous to compare fatal-accident data from one year to another without considering the economic conditions in the years compared.

Automobile accident rates or the number of highway-related deaths are often used in measuring the effectiveness of various vehicle and highway-system improvements. It seems imperative that factors other than the specific vehicle and highway-system changes affecting accidents and fatality levels should also be considered. For example, when comparing different model years of automobiles, data from the same calendar year must be treated with care because the kilometers driven per automobile, among other use factors, can vary with the age of the automobile (1). Comparing accident data where the ages of the automobiles are the same, but the calendar year of the data collection differs also can be hazardous, due to differences in the accident environment and in the factor that this paper will discuss, the economy.

A strong relation between the general performance of the economy and highway deaths has been suggested (1, 2). The data show that as economic performance improves, highway deaths increase. Various theories have been offered as explanations for this connection between highway mortality and economic prosperity. To date, no causes have been clearly identified.

ACCIDENT DATA

Fatal motor-vehicle accident counts given by the National Safety Council divided by the number of registered vehicles (the total of automobiles, buses, and trucks) given by the Federal Highway Administration were used as fatal-accident rates for this study. These accident rates may be more meaningful than fatal counts for automobile insurance companies and others concerned with per-vehicle measures of performance of the highway system.

The fatal-accident rates from 1949 to the present are shown in Figure 1. The overall trend of these data is depicted by the smooth curve drawn through the original data points.

The most striking feature of Figure 1 is the general downward trend in fatal-accident rates. This downward trend runs counter to population and vehicle trends. More specifically, exposure data, such as kilometers driven per vehicle, suggest an upward trend, because these have increased over the long term. However, some variations in kilometers per vehicle are reflected in the accident data. Factors that may have contributed to this reduction in the rate of fatal accidents include (a) the gradual phase in of improved vehicle and highway systems and (b) improved driving and safety performance.

The impact of the energy crisis on fatal-accident rates in 1974 can be clearly seen. The step-down in the trend line at 1974 reflects the incremental reduction in highway-fatality rates due to the establishment of the 88-km/h (55-mph) speed limits on major highways. The estimate of this effect of lower speed limits was derived from National Safety Council estimates of the effect on traffic deaths (3). This change, which affects all drivers and all vehicles, has had a powerful effect on automobile-fatality rates. With the maintenance of speed limits at this level, the lower overall rate should continue.

DATA REPRESENTING THE ECONOMY

Two types of data were used to represent the economy. The first was an indicator of the economy in general and consists of whether or not the nation was in a recession. The second was economic series, such as unemployment rates, that are thought to describe the economic conditions that directly affect the driving population.

General Economic Conditions: Recession Periods

Recessionary and nonrecessionary economic periods as delineated by the National Bureau of Economic Research (NBER) were used as indicators of the general economic condition of the country. An abbreviated description of the methods that NBER uses to determine recession periods appeared in the December 1, 1974, New York Times (4). A rough translation of the NBER's qualitative definition of a recession into a quantitative one is given in the article and listed below:

1. In terms of duration—declines in real gross national product (GNP) for two consecutive quarters and a decline in industrial production over a 6-month period;
2. In terms of depth—a 1.5 percent decline in real GNP, a 1.5 percent decline in nonagricultural employment, and a two-point rise in unemployment to a level of at least 6 percent; and
3. In terms of diffusion—a decline in nonagricultural employment in more than 75 percent of industries, as measured over 6-month spans, for 6 months or longer.

The recession periods delineated by NBER are shown as shaded areas in Figure 1.

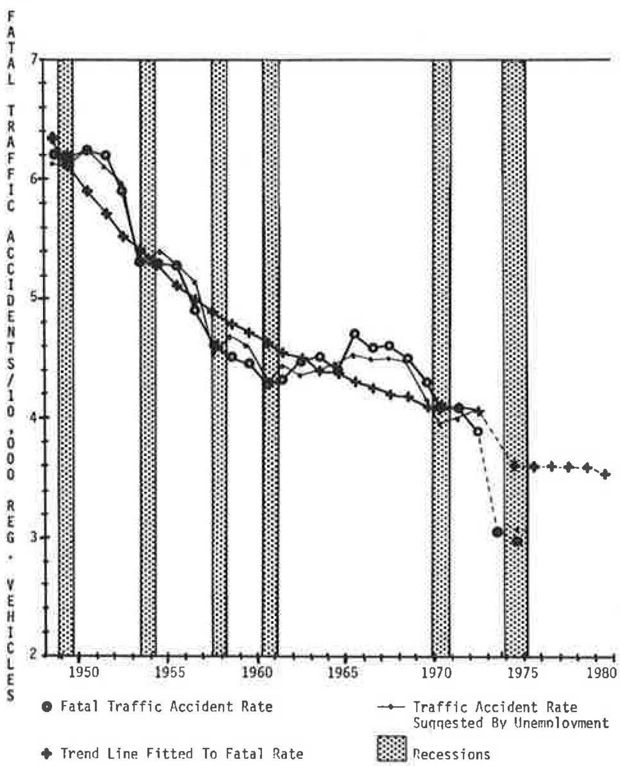
Specific Economic Series Chosen

The economic series were chosen to be used with a regression analysis. First, the series had to be representative of the economic factors that affect the driving population. Second, series with long-term trends were not considered because high correlations can be calculated that, due to the trend, are actually meaningless. Third, data for the series had to be available from 1949 to the present in a continuous manner.

Three types of economic well-being of the driving population are considered in this study: perceived, actual, and demonstrated. These three broad categories and the series chosen to represent each are shown below.

	Type of Series		
Type of Criterion	Representative of Economic Factors	No Long-Term Trend	Available from 1949 to Present
Perceived	Consumer sentiment	Consumer sentiment	—

Figure 1. Rates of fatal traffic accidents.



	Type of Series		
Type of Criterion	Representative of Economic Factors	No Long-Term Trend	Available from 1949 to Present
Actual	Unemployment, real wages, disposable income, and avg hours worked	Unemployment and avg hours worked	Unemployment and avg hours worked
Demonstrated	Consumption of goods, savings, kilometers driven, new automobiles purchased, and private housing		

[Consumer sentiment can be determined from the University of Michigan surveys (5) and unemployment data are available from the U.S. Department of Commerce (6).]

This table shows that most of the economic series chosen have long-term trends that are difficult to remove and thus fail the second criterion. Manipulations such as deflating the series and converting them to per capita measures do not remove the long-term upward trends in these series. These long-term upward trends are not represented in the frequency data. Of course, the upward pressures exerted by the economy may have been offset by the improvements in vehicles, highway systems, and driving performance.

The series that remain after eliminating those that fail one or more of the criteria are the unemployment rate and the average number of hours worked.

RELATIONSHIPS OF THE ECONOMIC AND FREQUENCY DATA

Unadjusted Accident Frequency

Figure 1 shows that there is a strong downward trend in the fatal-accident rate. This strong downward trend obscures many of the fluctuations of the accident frequency that are counter to it. However, there are regular fluctuations from the downward trend that can be isolated. The most consistent of these is a definite downward trend through each recession period. The second consistent fluctuation is a change in the rate of decline or actually an increase in the frequency after each recession.

No attempt was made to relate the fatal rates shown in Figure 1 to specific economic series. The main reason for this was the long-term downward trend in the data. It is not reasonable to assume that this downward trend has been generated by the economy because most economic measures actually suggest a long-term upward trend. Even kilometers driven per vehicle have increased over the period considered. Thus, improvement in safety per kilometer driven seems to dominate the factors affecting fatal-accident rates over the long term. However, significant downward fluctuations in the economic series from the long-term upward trend are represented in the accident frequencies as was suggested in the discussion of recessionary periods, since most economic series are affected in recessions.

Adjusted Accident Frequency

Because the long-term downward trend of the fatal-accident rate obscures the effects of the economy, an attempt was made to quantify or estimate the effects of the trend and remove it from the data. A smooth curve was fitted to the fatal-accident rate to represent the long-term trend, and although this curve cannot be described as an exact estimation of the downward trend, it is a plausible rough estimate. This estimate of the long-term downward trend accounts for 89 percent of the variance in the fatal-accident rate.

The long-term trend was then removed from the fatal-accident rate by subtracting the values represented by the fitted curve from the actual values. Linear regression was used to relate this detrended accident data to the specific economic series chosen. The relation of the unemployment rate with the detrended accident rate [correlation coefficient (r) = 0.86] is much better than that of the average number of hours worked with the detrended accident rate. The result of this part of the analysis is also shown in Figure 1. The estimated relation between the unemployment rate and the residual accident rate for 1949 to 1973 was used with the lowered trend line to estimate the point for 1975.

CONCLUSIONS

There seems to be a strong relation between the general economic performance and fatal-accident rates. Although the relationship is obscured by the strong downward trend in the accident-rate data, there are consistencies apparent in the data. Accident rates historically have decreased in recession periods and increased or changed in rate of decline after recession periods.

Of those specific economic measures studied, national unemployment rates showed the strongest relationship with fatal-accident rates, adjusted for the downward trend. As illustrated in Figure 1, the fitted rates closely follow the original fatal-accident rates. Because unemployment is an important part of the overall economic well-being of the country, the decrease and subsequent increase in accident rates through recession periods is also reflected in the estimated relationship between the unemployment and fatal-accident rates.

Because the performance of the economy seems to have an effect on accident rates, it may be hazardous to compare fatal-accident data from one year to another without also considering the economic conditions in the years compared.

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Analysis of Countywide Accident Data by Rate and Frequency

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A Highway Safety Program Standard (Identification and Surveillance of High Accident Locations) requires each state and local community to have an established procedure for the identification of high accident locations. The standard, however, specifies neither definite criteria nor procedures for the identification of such locations. Consequently, communities throughout the country use a variety of identification methods with varying degrees of success and accuracy. These range from the accident-frequency method to the accident-rate method and various combinations of them. The result of these procedures is the identification and selection of the most critical accident locations. A methodology for the analysis of large numbers of locations has been developed and implemented in Oakland County, Michigan, as part of a countywide comprehensive traffic engineering project. The methodology uses both accident-frequency and accident-rate data for each intersection and highway link to identify the most critical locations. The procedure stratifies the data from a number of intersections (or links) and assigns each location to a cell within a matrix that considers accident frequency on the horizontal axis and accident rate on the vertical axis. The locations contained in the cell corresponding to the highest frequency and the highest rate are identified as the most critical locations. Locations with a high frequency and a low rate or a high rate and a low frequency are considered less critical. A computer program was developed that determines the rate and frequency for all highway locations (intersections or links) being analyzed, assigns each location to the appropriate cell in the rate and frequency matrix, and then prepares reports indicating the locations contained in each cell and the pertinent data for each location. The rate and frequency analysis procedure was tested by using countywide accident data, as well as data from smaller political jurisdictions, and was an effective and valuable traffic-engineering tool.

Increased travel on our roads and highways is causing a corresponding increase in the number of accidents. However, when these numerical increases are compared with the higher travel loads, there has been a net decrease in accident rates (1). This decrease can be attributed, at least in part, to the positive effects of safety-improvement programs. Continued safety improvements require the comprehensive assessment of problem locations and subsequent corrective actions.

A Highway Safety Program Standard requires each state and local community to have an established procedure for identifying high-accident locations. Most communities identify such locations by considering either accident frequencies or accident rates and using assigned threshold values (2, 3). The use of a single indicator and an arbitrary threshold value, however, sometimes results in the selection of noncritical locations for improvements and may omit locations that are more critical.

STUDY OBJECTIVES

The object of this study was to develop a methodology that would stratify the highway locations in an area in a manner that would eliminate the possibility of selecting noncritical locations for remedial action. The basic steps in the countywide accident study were to

1. Develop a methodology that allows an analyst to establish the relative standing of all accident locations in a community;
2. Develop a computer program that can use the available accident data, determine the overall and by-type accident frequencies and rates, and generate a rate and frequency matrix indicating the relative standing of the intersection and highway-link locations in the county; and
3. Test the procedure with the Oakland County, Michigan, accident data to identify high-accident locations and to prove the validity of the system.

The frequency of accidents at an intersection or a link location is an important measure of safety conditions. A location, however, may have a low accident frequency and a very low traffic volume and thus a high accident rate, whereas another location may have a high accident frequency and a very high traffic volume and thus a low accident rate. It must then be determined which of the two locations is more critical.

Accident frequency is defined as the number of accidents at a location per year. Accident rate is defined (for intersection locations) as the number of accidents per million vehicles entering the intersection per year and (for links) as the number of accidents per million vehicle kilometers of travel per year.