REVIEW OF 1996 PROVINCIAL ROAD FATALITIES

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INTRODUCTION

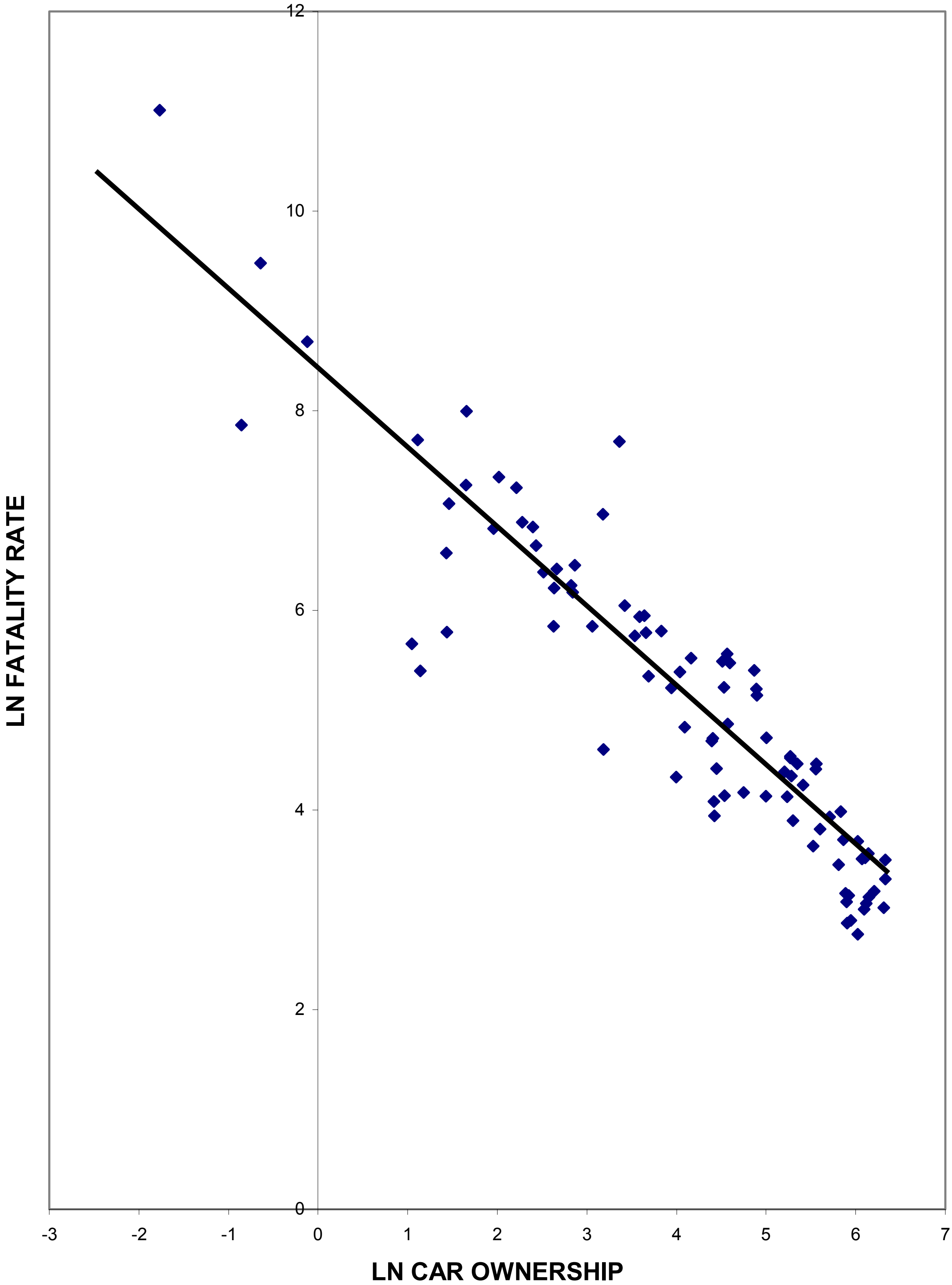
The road fatalities in the different provinces of South Africa are often compared – in the same way as the South African accident rate is compared to that of other countries. This is usually done during the holiday periods when, on a regular basis, the numbers are given in the media. During the "Arrive alive" campaign, the emphasis was placed on the three provinces with the highest annual number of fatalities namely Gauteng, the Western Cape and KwaZulu Natal. The question may be asked whether the roads in these provinces are actually less safe than the roads in the other six provinces? A second question that can be asked, is: Would it be possible to determine a reasonable number of fatalities per province that can be expected from the population, the number of vehicles and other variables pertaining to that specific province?

In this paper the fatalities and fatality rates of the different provinces will be compared in an effort to rank them from the safest to the least safe. Also, different transportation and socio-economic variables will be tested for their ability to explain the variation in the number of road fatalities in the provinces.

BACKGROUND

As early as 1949 Smeed[1] has shown that the fatality rate of a country can be related to the number of vehicles per capita or as it is also known, the rate of motorization. In a recent study[2] on international road fatality rates, it was found that the passenger car ownership is a better explanatory variable of fatalities per 100 000 passenger cars than vehicle ownership as an explanatory variable of fatalities per 100 000 vehicles. This logarithmic relationship is shown in Figure 1. Many people would argue that should the fatality rate of a country lie below the line, such a country can be considered as relatively safe – on the other hand, should it be above the line, the fatality rate is unacceptably high. South Africa is well above the line.

FIGURE 1: FATALITY RATE VERSUS CAR OWNERSHIP



In the same study it was also determined that many individual infrastructure and socio-economic variables have a significant effect on the fatality rate of a country. A model describing the fatality rates in 93 countries included the following three variables:

- Passenger car ownership;
- Human Development Index (HDI); and
- Percentage of vehicles other than passenger cars.

The purpose of this paper is to determine whether such a model would also be applicable to the nine provinces of South Africa.

PROVINCIAL DATA

The data that were used in the analyses were from the Central Statistical Services' publication[3]: "Statistics in brief" of 1997. Although more recent statistics for road fatalities are available, it is not so for some of the socio-economic data such as population and HDI. It was therefore decided that for the purpose of this paper it would be better to use statistics from the same period rather than the latest available statistics.

Data for the following variables were collected for each of the nine provinces:

- road fatalities;
- population;
- passenger cars registered;
- heavy vehicles registered;
- total vehicles registered;
- adult literacy rate;
- life expectancy;
- human development index (HDI);
- Gross Geographic product (GGP);
- hospital beds;
- energy use; and
- petrol and diesel sales.

From this information three types of fatality rate were calculated, namely the fatalities per million people, per 100 000 cars and per 100 million vehicle kilometres travelled (VKT). The latter were calculated from the fuel sales in each province. It was assumed that the average fuel consumption of petrol and diesel vehicles is 10,0 and 20,0 litres per 100 km respectively. These assumptions give an average distance of about 18 000 km per vehicle and a total distance of 123 billion km per annum – numbers that look quite reasonable for South African conditions.

It should be noted that there are many other factors that may have an effect on fatalities, such as:

- Urban/rural split
- Traffic speeds
- Law enforcement
- Vehicle occupancy
- Condition of vehicles and roads.

The data concerning these factors are, however, not available on a provincial basis.

ROAD FATALITIES AND FATALITY RATES

The fatalities and fatality rates of the nine provinces are shown in Table 1 as well as in Figures 2 and 3.

Table 1: Provincial road fatalities and fatality rates (1996)

Province	Fatalities	Fatality Rates		
		per 100 000 cars	per million people	per 100 million VKT
Western Cape	1286	178	312	6.8
Gauteng	2318	144	323	5.4
KwaZulu-Natal	2097	374	273	10.2
Free State	997	499	404	13.5
Eastern Cape	724	283	123	7.9
Northern Cape	326	478	437	12.5
North West	624	337	205	9.3
Mpumalanga	1191	635	450	13.7
Northern Province	693	598	168	11.0
Total/Average	10256	263	271	8.3

From this table it is can be seen that the majority of fatalities are found in Gauteng, KwaZulu-Natal and the Western Cape. Of the total number of fatalities, these three provinces contribute 56 percent. However, when the fatality rates are considered, it is clear that the situation changes drastically. The Western Cape and Gauteng have the lowest fatality rates in terms of car ownership and the distance travelled, but when it comes to the fatalities per capita, their fatality rates are higher than the average for the country. It is interesting to note that the fatality rates for Mpumalanga are consistently the highest of all the provinces. It could be said that the Eastern Cape was the best place to live and Gauteng the best place to own a car or to drive a vehicle in 1996.

To determine which provinces had the best safety record in 1996, they were ranked according to the different fatality rates after which an average ranking was determined. A number one ranking would mean the lowest rate and a number nine ranking the highest rate. The final ranking was done in a way similar to the ranking of the performance of unit trust companies. The results are shown in Table 2.

FIGURE 2: 1996 ROAD FATALITIES PER PROVINCE

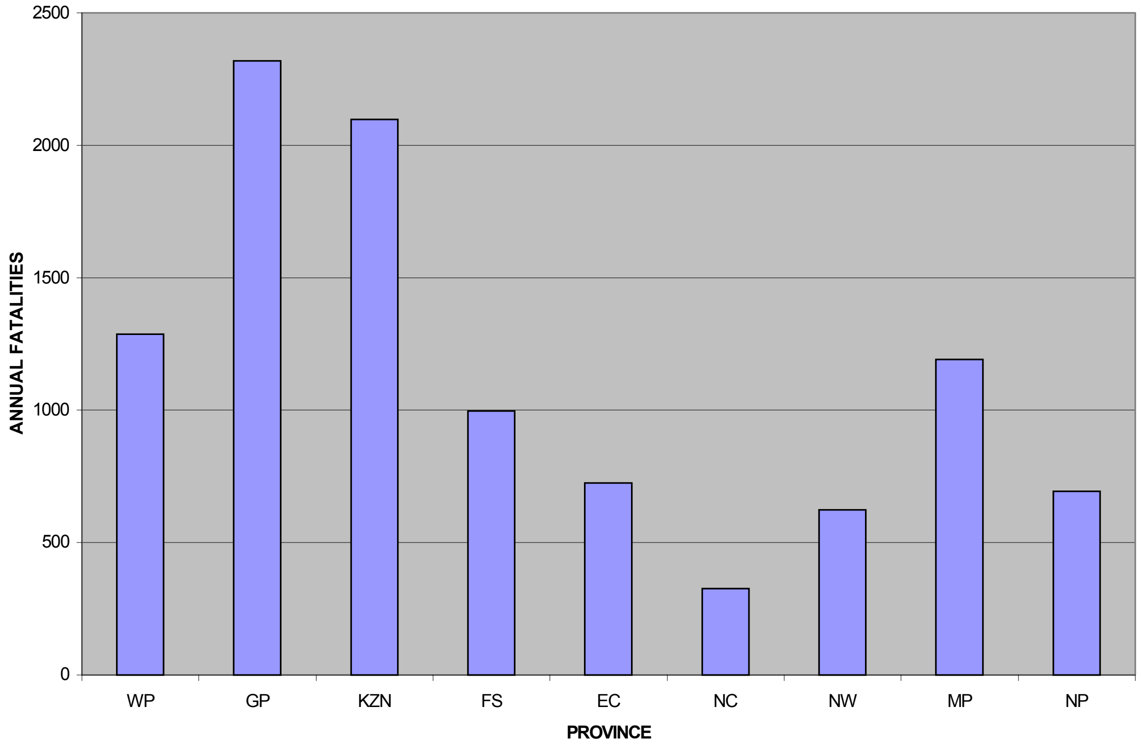


FIGURE 3: 1996 FATALITY RATES PER PROVINCE

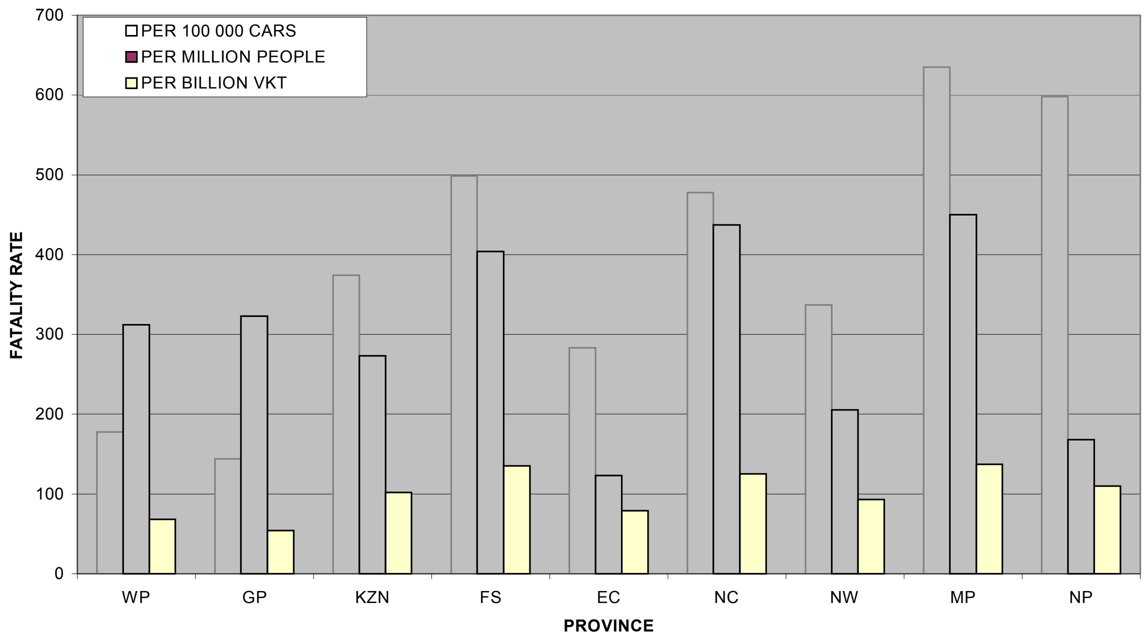


Table 2: Ranking of provinces in terms of road fatalities (1996)

Province	Ranking according to rates			Final ranking	
	per 100 000 cars	per million people	per 100 million VKT	Average	Final
Western Cape	2	5	2	3.0	3
Gauteng	1	6	1	2.7	2
KwaZulu-Natal	5	4	5	4.7	5
Free State	7	7	8	7.3	8
Eastern Cape	3	1	3	2.3	1
Northern Cape	6	8	7	7.0	7
North West	4	3	4	3.7	4
Mpumalanga	9	9	9	9.0	9
Northern Prov.	8	2	6	5.3	6

According to this procedure, the Eastern Cape was the safest province and Mpumalanga the province with the worst road safety record in 1996.

Another way of ranking the provinces would be to look at their position relative to the logarithmic relationship between the fatalities per 100 000 cars and the vehicle ownership in cars per 1 000 of the population. This relationship is shown in Figure 4. When the provinces are ranked from the one that is furthest below the line to the one furthest above the line, we get the same ranking as in Table 2 with the exception that the positions of the Northern Province and KwaZulu-Natal are reversed.

VARIABLES AFFECTING FATALITY RATES

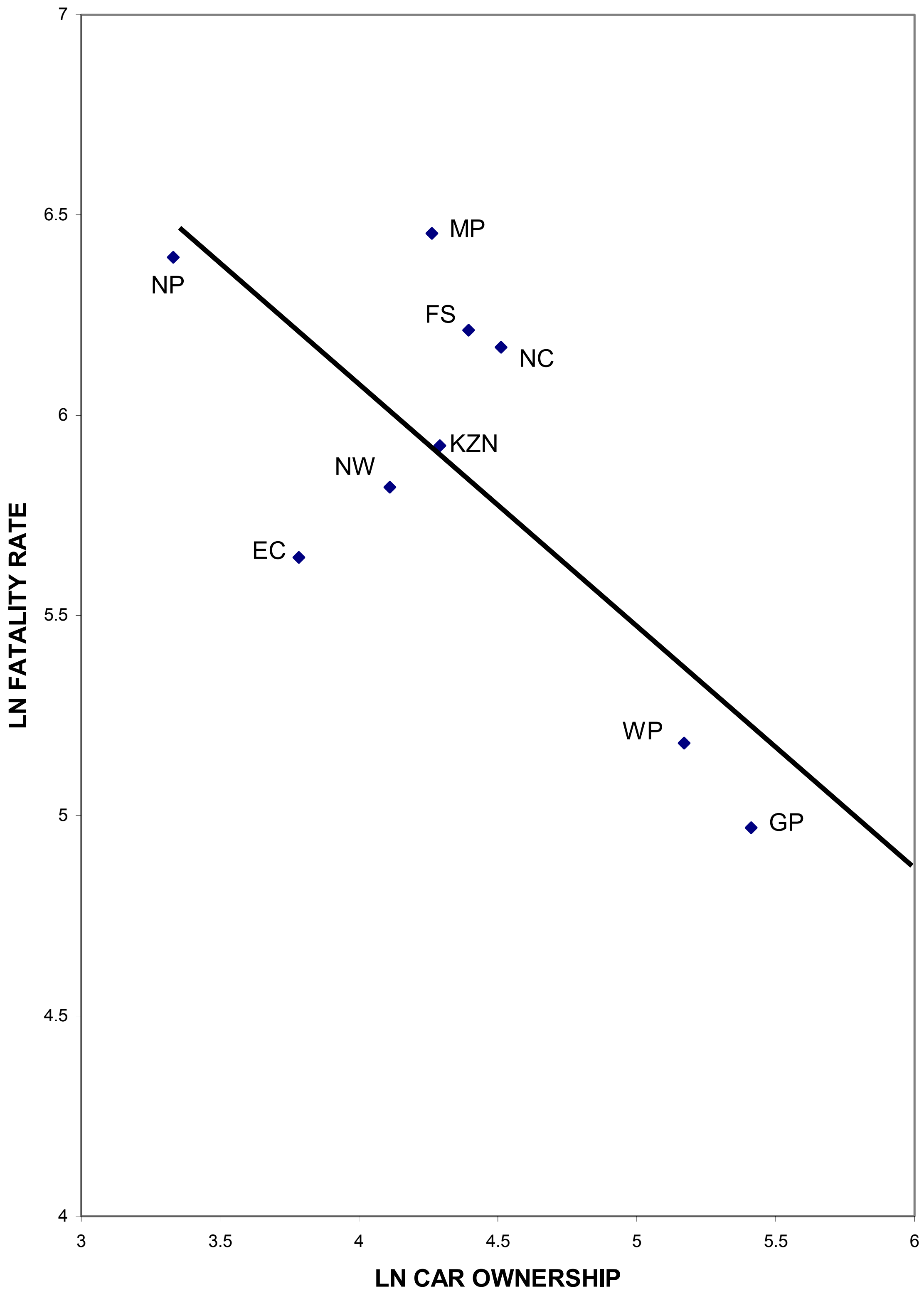
In the first step to determine the relevant variables, the correlation coefficients for the three types of fatality rate with the other socio-economic variables were determined. Because of the low number of data points (only nine), the confidence levels were generally low. Therefore only those correlation coefficients in excess of 0.55 were given further attention. Different combinations of the linear value as well as the natural logarithm ($\log_e$) of the variables were tested.

The fatality rate in terms of the VKT was correlated with the vehicle ownership in cars per 1000 of the population (R = -0.707). Therefore an increase in the vehicle ownership should lead to a decrease in this type of fatality rate.

The fatality rate in terms of the number of cars was correlated with the following socio-economic variables:

- car ownership (R = -0.808);
- percentage of heavy vehicles (R = +0.732);
- GGP per capita (R = -0.598);
- life expectancy (R = -0.599); and
- adult literacy rate (R = -0.635).

FIGURE 4:FATALITY RATE VERSUS CAR OWNERSHIP



All the signs of the correlation coefficients are as I expected. From the above, it can be seen that increases in vehicle ownership, GGP per capita, life expectancy and the adult literacy rate, should result in decreases in the fatality rate, while an increase in the percentage of heavy vehicles should lead to a an increase in the fatality rate.

When the fatality rate is expressed in terms of the population of a province, it seems as if the correlation coefficients all have the wrong sign. The relevant variables in this case was:

- energy use per capita (R = +0.766);
- Human development index (HDI) (R = +0.764);
- GGP per capita (R = +0.755); and
- car ownership (R = +0.591)

From these results it seems as if a higher level of development would lead to an increase in the fatality rate. However, because the rate is in terms of the population and not vehicles or vehicle use, it is clear that the effect of the larger number of vehicles in the more developed provinces has a greater positive effect on the number of fatalities than the negative effect of the improved living standards. This is in line with world-wide trends, where countries with a higher HDI have a greater number of fatalities per capita than the countries with a lower HDI. As an example, the United States of America with an HDI of 0.943 has a fatality rate of 153.4 fatalities per million people, whereas Zambia with an HDI of 0.369 has a fatality rate of 87.7 fatalities per million people.

MODELLING FATALITY RATES

For each of the three fatality rates a regression model was developed by means of a stepwise regression analysis. Only those socio-economic variables that would add significantly (at the 95% confidence level) to the model, are included as a result of this procedure. The three models are described in Tables 3, 4 and 5.

Table 3: Model fitting results for Log_e FATP100KC

Independent Variable	Coefficient	Std. error	t-value	Significance level
Constant	30.02	5.582	5.38	0.003
Log_e C1000POP	-1.713	0.337	-5.09	0.004
Log_e HDI	14.02	3.812	3.68	0.014
HDI	-15.96	6.274	-2.54	0.052

R^2 = 0.880

where:

FATP100KC = Fatality rate (fatalities per 100 000 cars)
C1000POP = Cars per 1 000 of the population
HDI = Human development index.

Table 4: Model fitting results for FATPOP

Independent Variable	Coefficient	Std. error	t-value	Significance level
Constant	5917.1	1233	4.80	0.005
Log_e C1000POP	-243.1	74.4	-3.27	0.022
Log_e HDI	3897.5	842	4.63	0.006
HDI	-4312.4	1385	-3.11	0.027

$R^2 = 0.886$

where:

FATPOP = Fatality rate (fatalities per million people).

Table 5: Model fitting results for FATRATE

Independent Variable	Coefficient	Std. error	t-value	Significance level
Constant	3.990	0.368	10.85	0.000
C1000POP	-0.00888	0.0016	-5.65	0.001
Log_e HDI	1.959	0.503	3.90	0.008

$R^2 = 0.811$

where:

FATRATE = Fatality rate (fatalities per 100 million VKT).

It is interesting that in all three cases the fatality rate of a specific province can be described by the car ownership and the HDI. The first two have the same form as the international model mentioned earlier, with the exception that the percentage of other vehicles is not included as a variable. The first model (Table 4) did include the percentage of other vehicles, but at the 90 % confidence level only. The fit of this model is shown in Figure 5. It is clearly better than the model shown in Figure 4.

PREDICTING PROVINCIAL ROAD FATALITIES

The models developed in the previous section can now be used to predict the fatalities of a province that should have occurred in 1996 in terms of the car ownership and the HDI. The results are shown in Table 6 together with the actual number of fatalities.

FIGURE 5: MODEL NUMBER 1 FIT

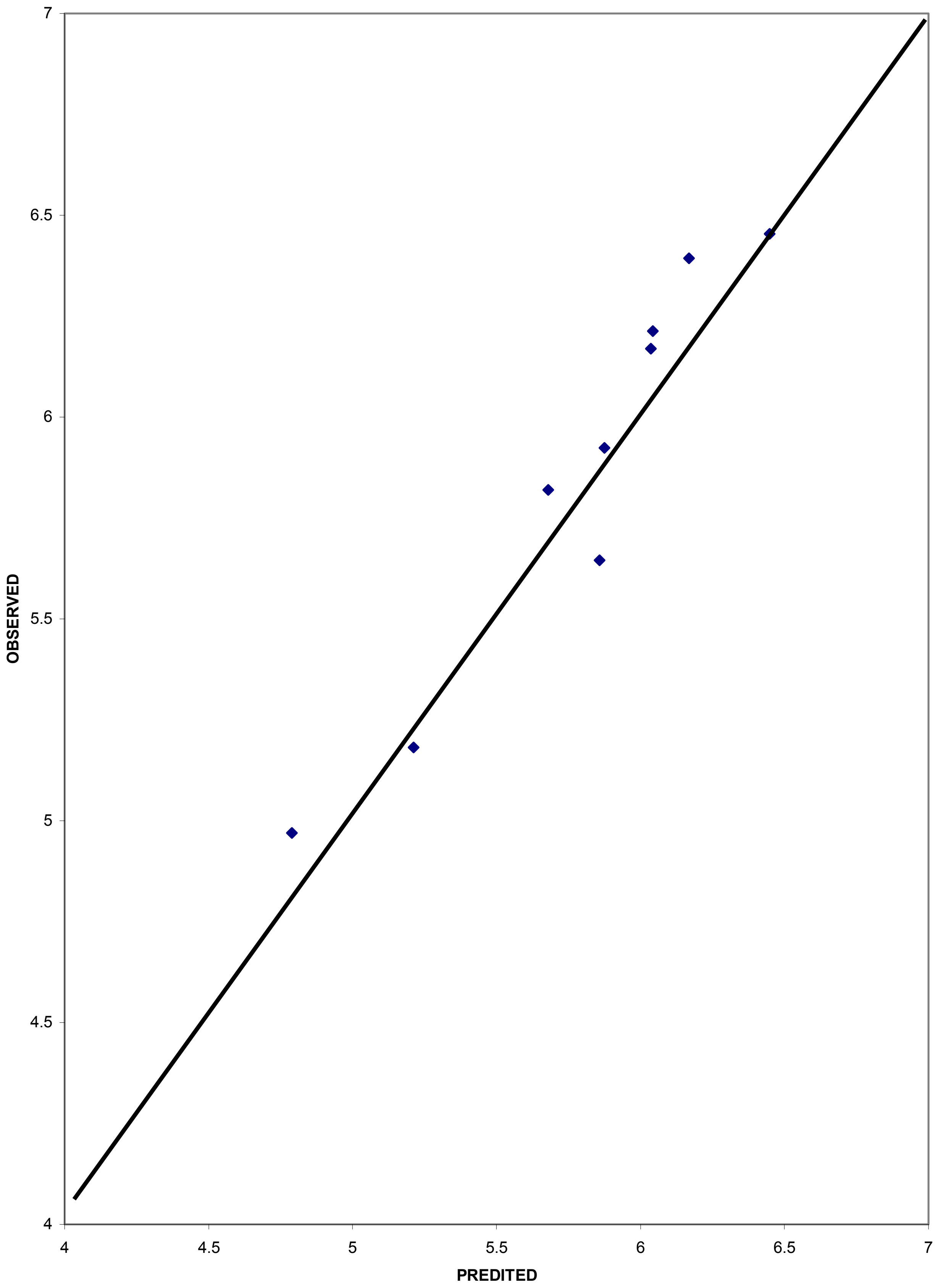


Table 6: Predicted versus observed number of fatalities

Province	Prediction according to model			Observed
	1 (Table 3)	2 (Table 4)	3 (Table 5)	
Western Cape	1450	1456	1478	1286
Gauteng	2119	2095	2146	2318
KwaZulu-Natal	2147	2304	2148	2097
Free State	907	935	857	997
Eastern Cape	952	962	888	724
Northern Cape	307	307	312	326
North West	582	597	636	624
Mpumalanga	1276	1231	1225	1191
Northern Prov.	586	570	603	693
TOTAL	10326	10457	10293	10256

It is interesting to note that all three models will overestimate the number of fatalities for the Western Cape, KwaZulu-Natal, the Eastern Cape and Mpumalanga. All three will underestimate the number of fatalities for Gauteng, Free State, Northern Cape and the Northern Province. Two models will underestimate and one will overestimate the number of fatalities in North West. Not one of the models differs by more than 10% from the others.

Another procedure to predict the number of fatalities in a province would be to consider each province as a country on its own and then use the international model together with the appropriate values of the variables for the provinces. This model is as follows:

$$\text{Ln FATP100KC} = 18.066 - 0.633 \text{ Ln C1000P} + 6.65\text{Ln HDI} - 11.447 \text{ HDI} + 0.0160 \text{ PEROTHER} \quad \ldots\ldots(1)$$

where:
PEROTHER = Percentage of other (not passenger cars) vehicles

By using this model, another picture emerges. The results are shown in Table 7.

Table 7: Prediction of Provincial fatalities with international model

Province	Predicted	Observed	Ratio Obs/Pred
Western Cape	740	1286	1.74
Gauteng	1424	2318	1.63
KwaZulu-Natal	1748	2097	1.20
Free State	679	997	1.47
Eastern Cape	1077	724	0.67
Northern Cape	206	326	1.58
North West	762	624	0.82
Mpumalanga	648	1191	1.84
Northern Prov.	752	693	0.92
TOTAL	8036	10256	1.28

Overall, the observed number of fatalities in South Africa in 1996, was 28% higher than the number predicted by the international model. The provinces with a ratio of more than unity are experiencing more fatalities than the number predicted according to the independent variables. This could be an indication of an unacceptable situation. However, three provinces have fewer fatalities than the numbers predicted. This could be an indication of a relatively more safe situation. Considering these ratios, it could indicate again that the Eastern Cape was the safest province and Mpumalanga the unsafest.

CONCLUSIONS

It has been shown that it is possible to explain some of the variation in provincial road fatalities by means of regression models and socio-economic variables such as car ownership and the HDI. These models are of a similar form than a previous international model that was calibrated for 93 different countries. However, the international model suggests that for South Africa's level of development and car ownership, the observed fatalities in 1996 were 28 % too high.

When comparing the fatalities and fatality rates of the provinces in South Africa, it is clear that, whatever the criteria, the Eastern Cape has the best and Mpumalanga the worst road safety record.

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