Different Speed Limits for Cars and Trucks: Do They Affect Vehicle Speeds?

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During 1987 and 1988, 40 states opted to take advantage of the 1987 federal law allowing them to raise the speed limit on rural Interstates from 55 to 65 mph. The majority of these states raised the limit to 65 mph for all vehicles; however, 10 states chose a lower speed limit for trucks than for cars. Vehicle speeds were measured on rural Interstates in California and Illinois, which have a differential speed limit, and in Arizona and Iowa, which have a uniform speed limit. A posted differential speed limit on rural Interstates was found to reduce high truck speeds on the faster roads. Trucks are a smaller percentage of the high-speed traffic in states with differential speed limits than in states with uniform speed limits when average car speeds exceed 63.4 mph. Specifically, for each 1-mph increase in mean car speeds over 63.4 mph on rural Interstates, the odds relative to cars of a truck traveling about 70 mph decreases by 20 percent in the states with differential speed limits compared with states having uniform speed limits. Analysis of the mean speeds revealed that trucks travel 1.4 mph slower in states with differential speed limits than in those without. This difference increases to 3.0 mph for the fastest 5 percent of trucks.

Between 1973 and 1987, the maximum speed limit for all vehicles traveling on Interstate highways was 55 mph. In April 1987 Congress passed the Surface Transportation and Uniform Relocation Assistance Act (P.L. 100–17), which allowed states to raise speed limits from 55 to 65 mph on segments of the Interstate highway system outside densely populated areas. States may post a 65-mph speed limit on segments of the Interstate highway system that are defined by FHWA as rural or not within an area of 50,000 or more population. All other segments remain with 55-mph limits. Before 1973, many states had different speed limits based on vehicle type; for example, in Missouri cars were permitted to travel 70 mph, whereas trucks were limited to 60 mph. With the 55-mph national maximum speed limit removed, states were faced with the question of whether to set new speed limits uniformly for all vehicles or to set different limits for cars and other vehicles.

Speed limits are designed to reduce the frequency and severity of crashes by decreasing the number of vehicles traveling at excessively high speeds. The rationale for a lower maximum limit for trucks is that, from any given speed, heavier vehicles such as trucks require longer to brake and decelerate to a complete stop than do lighter vehicles such as cars (*1*). The lower limits for trucks may make stopping distances for cars and trucks more comparable and provide for a more orderly traffic flow (e.g., facilitate passing) (*2*). Opponents of the differential limit maintain that the lower limit for trucks may increase the variation in vehicle speeds and cause an increase in the number of interactions or conflicts between vehicles (*3*).

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In the United States, the 55-mph national maximum speed limit was applied uniformly to all vehicles. Consequently, studies of different speed limits for cars and trucks were either done before 1973 or after 1987. A study conducted by the Civil Engineering Department at the University of Maryland (*4*) before enactment of the 55-mph national maximum speed limit found poor adherence by both cars and trucks to posted limits. At most locations with a 10-mph posted differential, the actual differential was 6 mph. On rural national routes in Ireland, where a 15-mph differential for cars and trucks was posted in 1979 (55 mph for cars and 40 mph for trucks), the observed differential was 7.4 mph (*5*).

Of the 40 states that raised the speed limit on rural Interstates, 10 set differential speed limits for cars and larger vehicles. Seven states have 65 and 55 mph limits, and the other 3 have 65 and 60 mph limits. Several states also have separate restrictions for school buses traveling on Interstates. These new driving environments allow examination of the relationship between a differential speed limit and travel speeds. A study was conducted to determine whether a differential speed limit—55 mph for trucks and 65 mph for passenger vehicles—results in a significant difference in vehicle speeds. Travel speeds were measured in states with differential speed limits and in other states with uniform speed limits, and the results were compared.

METHOD

Data

Data were collected on rural Interstates in two states with differential speed limits by vehicle type (California and Illinois) and in bordering states with uniform speed limits (Arizona and Iowa). In California the 55-mph speed limit applies to all trucks, automobiles pulling trailers, and other combination vehicles; in Illinois it applies to trucks over 4 tons, mobile homes, and vehicles pulling trailers. In both states the speed limit is 65 mph for passenger vehicles and light trucks. In Arizona and Iowa the speed limit is 65 mph for all types of vehicles.

In each state data were collected from three sites on rural Interstates for 24-hr periods in dry weather during April or May 1988. The sites were geographically and environmentally similar, and the roadway was straight and level at these sites. All sites were two-lane roads, and at least 5 mi from state borders and at least 1 mi from highway exits and entrances. Specific locations were as follows:

- *California.* Near Barstow on I-40 at 0.8 mi east of Daggett-Yermo Road (Site 1), near Indio on I-10 east of Dillion Road (Site 3), and near Boulevard on I-8 west of Route 94 (Site 4);
- *Arizona.* Near Flagstaff on I-40 at Milepost 126 (Site 5), near Yuma on I-8 at Milepost 94 (Site 4), and near Phoenix on I-10 at Milepost 94 (Site 2);
- *Illinois.* Champaign-Urbana on I-74 at Milepost 178 (Site 5), at Mt. Vernon on I-64 at Milepost 68 (Site 1), and at Effingham on I-57 at Milepost 168 (Site 3); and
- *Iowa:* Iowa City on I-80 at Milepost 222 (Site 4), near Council Bluffs on I-80 at Milepost 33 (Site 5), and near Ellsworth on I-35 at Milepost 136 (Site 3).

Data on individual vehicle speed, length, lane position, and time of day were collected using the International Road Dynamics Traffic Statistics Recorder Model 1040. When feasible, the recorder was connected to the in-pavement inductance loops maintained by the states at their permanent speed-monitoring stations. When an appropriate state monitoring site could not be located, inductive loop mats were used.

The recorder provided a raw count of the number of vehicles that crossed over at least one of the loops. In addition, the recorder provided error diagnostics, including counts of the number of passing vehicles (vehicles traveling the opposite direction to the normal traffic flow), the number of loop errors, and the number of upstream and downstream errors that occurred when a vehicle failed to pass over both mats.

A vehicle record was processed if the recorded speed was less than 999.99 km/hr, recorded within the 24-hr period, and the error code contained one of the two valid vehicle codes. The raw data were converted from metric to U.S. customary units. Records indicating a vehicle length less than 100 in. were discarded, as were records indicating a vehicle speed less than 20 mph or greater than 110 mph.

Vehicles identified from records indicating vehicle lengths of 20 ft or less, which includes cars and light trucks, were classified as cars. Records with vehicle lengths greater than 20 ft were classified as trucks, which includes buses, straight trucks, bobtails, and tractor-trailers. Occasionally, the loops had difficulty detecting trucks, possibly because of a lack of metal in the trailer or the height of the trailer from the roadway. For these sites, additional classification criteria were used. When the time lag between two successive vehicles in a lane was less than 1 sec and the first vehicle had valid speed and length measurements, the first vehicle was categorized as a truck and the second vehicle record was disregarded.

The percentages of records retained at each site are presented in Table 1. Generally, 90 percent or more of the vehicle records at a given site were used in the analysis. The one exception is the Iowa City site, for which only 59 percent of the records were used. The field engineers reported difficulty tuning the inductance loop at this site. As a consequence, the sensitivity of the loop was increased, resulting in spurious signals; thus, fewer records from the total raw count at this site were used in the analysis.

TABLE 1 PERCENTAGE OF VEHICLES WITH VALID SPEEDS AND LENGTHS BY STATE AND LOCATION

State	Location	Raw Count	Valid Vehicles	Percent
California	Barstow	4,538	4,385	97
	Indio	5,679	5,066	89
	Boulevard	3,742	3,554	95
Arizona	Phoenix	4,892	4,720	96
	Yuma	2,050	1,957	95
	Flagstaff	3,966	3,879	98
Illinois	Mt. Vernon	6,477	5,876	91
	Effingham	4,860	4,719	97
	Champaign-Urbana	9,742	9,379	96
Iowa	Ellsworth	5,871	5,491	94
	Iowa City	10,468	6,168	59
	Council Bluffs	6,107	6,002	98

Analyses

Ideally, measurements should have been made before and after the speed limit change on each of the roadways studied. However, the appropriate data from before the change were unavailable. Data gathered by the states to meet federal compliance standards do not indicate vehicle length, and the speed measurements are classified into 5-mph groups. Therefore, data from states with uniform speed limits were used as a comparison for states with differential speed limits.

In describing the data, speed distributions were compared among sites for mean speeds, selected percentile speeds, and the percentage of vehicles exceeding 70 mph. Imposing a lower speed limit on trucks was expected to reduce the number of high-speed trucks; however, it was also possible that lower truck speeds would translate into lower car speeds because of interaction among vehicles that share the same highways.

This hypothesis was tested using analysis of variance. The data were divided into five time periods: early morning (12:00 to 5:59 a.m.), morning rush hour (6:00 to 8:59 a.m.), midday (9:00 a.m. to 3:59 p.m.), evening rush hour (4:00 to 6:59 p.m.), and night (7:00 to 11:59 p.m.). The initial model treated mean truck speeds as a function of the speed limit (differential versus uniform speed limit), region of the country (West versus Midwest), day versus night, and the interaction of speed limit and region. All linear models were fitted using the general linear modeling procedure of the SAS Institute, Inc. (*6*). Weighing was not used because a small, but not statistically significant, negative relationship was detected between truck speed and number of trucks. This relationship implied that, the more trucks on the road at a given time, the lower the overall truck speeds. Therefore, weighing on the basis of sample size would have confounded the speed result.

To the extent that changes in car speeds and truck speeds among sites are parallel, any haphazard but systematic association between the 55-mph truck speed limit and average car speeds would result in biased estimates for the effect of that speed limit on truck speeds. To determine the relationship between truck speed limit and average car speeds, the truck speed analysis described previously was repeated for car speeds. Average truck speeds were plotted against average car speeds, and a positive association was noted.

Because of the association between car and truck speeds, truck speed differences among sites could be caused, in principle, not so much by lower truck speeds but to lower average speeds at a site. Hence, the corresponding car speed characteristic was used as a covariable in the analysis of truck speeds (average speed and selected percentile speeds). Separate analysis of covariance (ANCOVA) models were estimated for each speed characteristic, and each model included the differential speed limit (limit) and time of day (using the five time periods) as main effects. Car speed (speed), the covariable, was allowed to vary by whether there was a differential speed limit (speed * limit). Site variability was accounted for by using a nested effect [site(limit)].

The effect of differential speed limits on reducing the proportion of trucks among high-speed vehicles is measured using 70 mph as the speed separating low and high speeds. In order to test whether the lower speed limit was effective in reducing the proportion of high-speed trucks, an odds ratio was computed for each time of day at each site. This ratio (OR) is defined as the ratio of the odds that a vehicle traveling at or about 70 mph is a truck divided by the odds that a vehicle below that speed is a truck. This ratio can be written as follows:

$$\mathrm{OR} = \frac{\mathrm{TG/CG}}{\mathrm{TL/CL}}$$

where TG is the percentage of trucks exceeding 70 mph, TL is the percentage of trucks traveling 70 mph or less, and CG and CL are the corresponding percentages for cars. The greater the ratio OR, the greater the proportion of very fast trucks at the site.

The natural logarithm of the 60 odds ratios (four states × three sites × five time periods) were modeled using the maximum likelihood method as implemented in the CATMOD procedure of the SAS Institute, Inc. The model used is similar to that used in the ANCOVA analyses (effects included were limit, time, speed, and speed * limit). The interaction term was included because the effect of the differential speed limit laws may depend on the speed of other vehicles at the site.

The effect of differential speed limits on speed variance is not intuitively obvious. If the limits separate the traffic stream into low-speed trucks and high-speed cars, the variance would increase; however, if the limits mostly reduce high-speed trucks, the variance would remain constant or decrease. The effect of the limits on variance was estimated using an analysis of variance (ANOVA) model with day, limits, and region as main effects and the joint effect of limit by region as an interaction term.

RESULTS

The raw mean speeds by state are presented in Table 2. Trucks traveled 2.73 mph slower in the states with differential speed limits than in those with uniform speed limits. However, when adjusted for the mean speeds of cars, the difference decreases to 1.8 mph.

Using the ANOVA model, average truck speeds were estimated to be 2.7 mph less in states with differential speed limits than in states with uniform speed limits. This difference was statistically significant ($F = 12.11, p < .01$). (Estimated results refer to the least squares estimates from the model for a given speed characteristic and the specified categories of the variable.) None of the other effects (region, day, or region speed limit) were significant at the .05 level. The similar model for cars had significant effects for limit ($F = 5.13, p = .03$) and region by limit ($F = 6.01, p = .02$). The day versus night effect was not significant in either model and was dropped in subsequent analyses; however, because it is desirable to maximize the number of data points, the remaining analyses used the five time periods.

TABLE 2 MEAN SPEEDS BY STATE AND VEHICLE TYPE

Speed Limit type	State	Trucks	Cars
Uniform	Arizona	61.1	66.4
	Iowa	62.3	65.4
Differential	California	58.2	63.8
	Illinois	59.7	65.4

The estimated adjusted mean and percentile speeds for trucks versus observed car speeds (mean, 85th percentile, 90th percentile, and 95th percentile) from the ANCOVA models are shown in Figure 1. These estimates were slightly different from the unadjusted ones; however, the association of lower truck speeds among the states with differential speed limits remains even after accounting for differences in car speeds. The difference in estimated truck speeds was largest for the 95th-percentile speed (3.0 versus 1.4 mph for the mean speed), indicating that the differential speed limits are having the greatest effect on high-speed trucks. Speed limit was only significant for the 95th-percentile speed. Also, for each speed characteristic, the observed speeds for cars were less in the states with differential speed limits than in those with uniform limits. For example, the 90th-percentile speed for cars in the states with differential speed limits was 71.9 mph compared with 73.1 mph in the states with uniform limits.

Table 3 presents the percentage of trucks and cars exceeding 70 mph by state, site, and time period. The numerical average over all sites within a state indicates that the percentage of trucks going faster than 70 mph was twice as large in the uniform-limit states as in the differential-speed-limit states (13.8 percent in Arizona, 4.0 percent in California, 9.0 percent in Iowa, and 3.2 percent in Illinois). There was little difference by region in the percentage of cars exceeding 70 mph (26.6 percent in Arizona and 20.3 percent in California; 16.6 percent in Iowa and 18.5 percent in Illinois).

The odds ratios reflecting the likelihood of trucks exceeding 70 mph at each site differed significantly by type of speed limit, but only when mean car speeds exceeded 63.4 mph. For every 1-mph increase in speeds above 63.4 mph, the ratio of the odds ratios declines by 20 percent, implying a decrease in the proportion of trucks exceeding 70 mph in the states with differential speed limits relative to the same proportion in states with uniform speed limits. The speed of 63.4 mph represents the point at which the odds ratio in states with differential speed limits equals the odds ratio in states with uniform speed limits.

Finally, speed variance, across vehicle types, was slightly smaller in the states with differential speed limits than in the states with uniform limits (42.7 versus 44.7 mph), but the

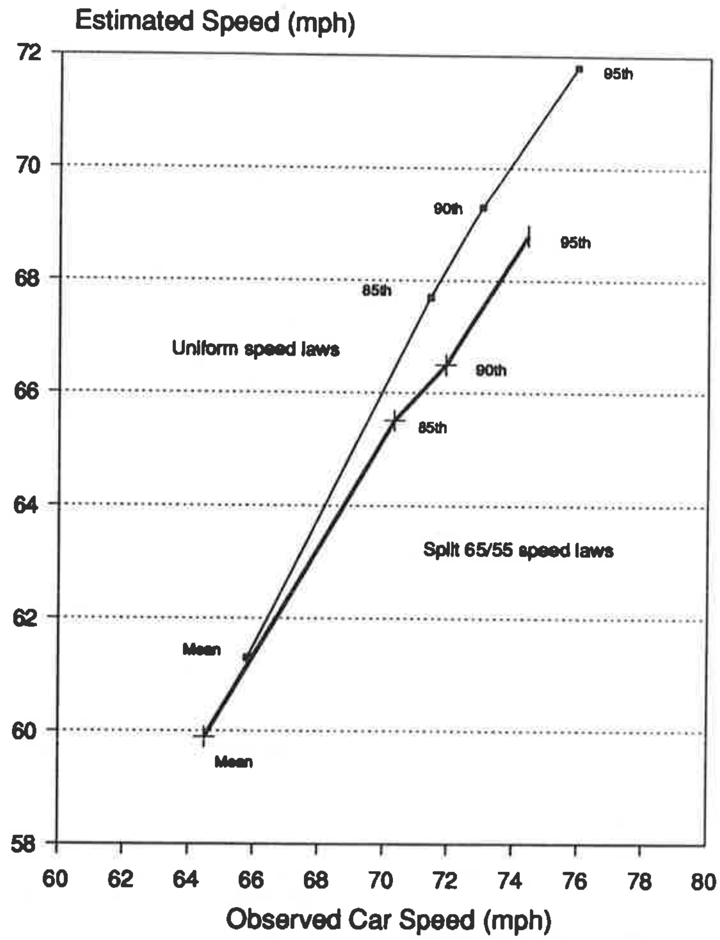

FIGURE 1 Model estimates of mean and percentile truck speeds versus comparable car speed characteristics by speed law.

difference was not statistically significant. Region of the country yields the only statistically significant effect. Speed variance in the two western states was 28 percent greater than in the midwestern states (49.1 versus 38.3).

DISCUSSION OF RESULTS

Each of the models indicates that truck speeds are lower in states with a differential speed limit for cars and trucks than in states with uniform speed limits. The magnitude of the difference varies according to which model was used. When the general traffic flow as measured by car speeds was not considered, the mean difference in truck speeds was 2.7 mph (ANOVA model), which dropped to 1.4 mph (ANCOVA model) after the adjustment was made. The former was statistically significant, whereas the latter was not. The ANCOVA model does yield a significant effect for the 95th-percentile speed. For sites with average car traffic speeds in excess of 63.4 mph, the percentage of trucks traveling very fast (70 mph or above) on rural Interstates declined dramatically in the differential speed limit states relative to the same percentage in the states with uniform speed limits.

The differences in mean speed are small; however, as expected, the main effect is in reducing the percentage of trucks exceeding 70 mph. Thus, it is likely that reducing the percentage of high-speed trucks will reduce the number and severity of highway crashes. The use of 70 mph as a cutoff is reasonable given that 70 mph is the nominal design speed for rural Interstate highways. Also, the average car speeds at all the sites (except one) for each time period (except one) were faster than the 63.4-mph threshold predicted by the model. It is also likely that the average speed will continue to increase as drivers become accustomed to the new higher limits, thereby enhancing the effect a differential speed limit could theoretically produce.

Differential speed limits may increase the variance in speeds of vehicles. However, the data do not indicate that speed variance is different in states with differential speed limit laws versus those without these laws.

Because of the large variation by site, region was discounted in importance early in the study; however, for clarity some of the final models were run separately by region. The magnitude of the effect of the differential speed limit does seem to be stronger in the Midwest than in the West, but the difference is not statistically significant and is primarily caused

TABLE 3 PERCENTAGE OF TRUCKS AND CARS EXCEEDING 70 mph BY STATE, SITE, AND TIME

			Percent ≥ 70 mph	
State	Site	Time	Trucks	Cars
Arizona	A	0:00 - 5:59	25.4	42.6
		6:00 - 8:59	31.7	40.4
		9:00 - 15:59	25.7	32.7
		16:00 - 18:59	19.6	33.4
		19:00 - 23:59	21.4	38.5
	B	0:00 - 5:59	23.1	22.7
		6:00 - 8:59	17.4	22.5
		9:00 - 15:59	9.8	23.3
		16:00 - 18:59	14.8	23.1
		19:00 - 23:59	8.7	20.4
	C	0:00 - 5:59	1.2	18.1
		6:00 - 8:59	0.0	14.5
		9:00 - 15:59	0.4	17.0
		16:00 - 18:59	0.4	24.0
		19:00 - 23:59	0.8	16.8
California	A	0:00 - 5:59	9.7	24.8
		6:00 - 8:59	11.8	33.0
		9:00 - 15:59	6.1	28.4
		16:00 - 18:59	12.2	36.4
		19:00 - 23:59	3.4	24.4
	B	0:00 - 5:59	0.7	4.0
		6:00 - 8:59	0.0	1.1
		9:00 - 15:59	0.1	0.7
		16:00 - 18:59	0.0	2.0
		19:00 - 23:59	0.2	2.3
	C	0:00 - 5:59	29.0	27.4
		6:00 - 8:59	15.4	21.9
		9:00 - 15:59	7.0	32.7
		16:00 - 18:59	5.5	30.5
		19:00 - 23:59	7.4	19.2
Iowa	A	0:00 - 5:59	2.4	10.3
		6:00 - 8:59	2.5	11.8
		9:00 - 15:59	4.7	14.8
		16:00 - 18:59	4.4	12.5
		19:00 - 23:59	9.8	14.2
	B	0:00 - 5:59	0.0	17.1
		6:00 - 8:59	15.3	36.0
		9:00 - 15:59	12.5	17.8
		16:00 - 18:59	29.4	22.3
		19:00 - 23:59	23.2	22.3
	C	0:00 - 5:59	5.8	14.0
		6:00 - 8:59	3.0	15.5
		9:00 - 15:59	1.0	13.9
		16:00 - 18:59	2.2	14.3
		19:00 - 23:59	4.8	18.1
Illinois	A	0:00 - 5:59	3.9	28.7
		6:00 - 8:59	1.9	20.7
		9:00 - 15:59	2.9	22.1
		16:00 - 18:59	4.5	26.5
		19:00 - 23:59	1.0	23.2
	B	0:00 - 5:59	4.7	18.2
		6:00 - 8:59	3.5	16.1
		9:00 - 15:59	4.4	18.7
		16:00 - 18:59	4.8	14.5
		19:00 - 23:59	5.2	19.5
	C	0:00 - 5:59	2.5	12.3
		6:00 - 8:59	3.6	20.1
		9:00 - 15:59	2.2	14.2
		16:00 - 18:59	2.1	18.2
		19:00 - 23:59	1.7	13.0

by one slow site in California. If this site is treated as an outlier, there is no evidence of a regional effect.

Lower speed limits have been found to be associated with a reduced number of motor vehicle injuries, but the relationship between differential speed limits and crashes or injuries has yet to be determined. This study has shown that differential speed limits do reduce the speeds of the fastest trucks with no apparent increase in speed variance. The next step is to determine whether this effect translates into a different pattern of motor vehicle injuries than that in states with uniform 65-mph limits.

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