Despite critics' claims, SUVs are saving lives.

The Truth About Light Trucks

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THE AMERICAN LOVE AFFAIR WITH the automobile has grown to include the class of vehicles known as "light trucks," which includes minivans, pickups, small vans, and the much-maligned sport utility vehicles (SUVs). American consumers are now buying as many new light trucks as they are buying new cars, and 40 percent of all registered passenger vehicles on U.S. roads are light trucks — double the percentage in 1980.

Despite these vehicles' popularity, federal regulators have expressed concern over the effects they may have on highway safety. Light truck critics have charged that the vehicles' size and weight endanger other drivers in a multiple-vehicle collision. Ricardo Martinez, the former head of the National Highway Traffic Safety Administration (NHTSA), declared in 1998 that if the light trucks on the nation's roadways were replaced with cars, up to 2,000 lives could be saved annually.

Martinez based his conclusion, in part, on an NHTSA-sponsored study that showed disproportionate fatalities among car occupants when the cars were involved in fatal accidents with light trucks. This research indicated that, in front-impact crashes with light trucks, the relative fatality risk for car drivers was three to six times greater than the risk to the light truck drivers. For side-impact accidents where a light truck struck a car, car driver fatalities were between eight and 30 times higher than light truck driver fatalities. In comparison, car driver fatalities were only seven times higher when another car was the striking vehicle in the side-impact collisions.

NHTSA is not the only body to criticize the roadway safety of SUVs and other light trucks. The Insurance Institute for Highway Safety, in a 1998 report entitled "Crash Compatibility," also presented evidence indicating higher relative risks for car occupants when involved in fatal crashes with light trucks. In side-impact crashes between cars and pickups or SUVs for model years 1990 through 1995, car occupant fatalities were 25 times higher than light truck occupant fatalities when the light trucks were the striking vehicles. This compared to a relative risk for car occupants that was only six times higher in side-impact fatal crashes when another car was the striking vehicle. For frontal impact fatal crashes with pickups and SUVs, the relative risk for car drivers was three to four times greater than the risk to the light truck drivers.

The Insurance Institute statistics also indicated that small pickups and small SUVs have higher rollover fatality rates than cars. In 1997, the number of single-vehicle rollover crash deaths per million registered vehicles was 77 for pickups under 3,500 pounds and 124 for SUVs with wheel bases under 100 inches. Small and midsize cars had single-vehicle rollover crash deaths of 35 per million registered vehicles. One explanation for the higher light truck rollover rate is that those vehicles typically have greater ground clearance and a higher center of gravity than cars.

Despite the claims of NHSTA and other groups, it is not clear that the increase in light truck use has produced an increase in traffic accident fatalities. The past two decades have not only seen a doubling of the percentage of light trucks on the nation's roads, but a one-third decrease in traffic accident fatalities per capita, fatalities per licensed driver, and fatalities per registered vehicle. The United States has also experienced a nearly 50-percent decline in fatalities per vehicle mile traveled. This suggests that the large, stiff-framed light trucks may be lowering traffic fatalities instead of increasing them.

Light truck critics will try to dismiss this notion by claiming that the improving fatality trends are the products

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of stiffer penalties for drunk driving, increased seat belt use, the reintroduction of the 55 mph speed limit in some states, and safety-enhancing technological change. No doubt, these policies and developments have affected roadway safety. But we believe that the increased percentage of SUVs and other light trucks on the road has also lowered, and not increased, the fatality rate.

LIGHT TRUCKS AND FATALITIES

MOTOR VEHICLE FATALITIES AND LIGHT TRUCKS ARE both more prevalent in rural areas of the United States than in urban areas. In 1997, there were two motor vehicle fatalities per 10,000 licensed drivers in the ten most densely populated states as compared to three fatalities per 10,000 in the ten states with the lowest population densities. At the same time, light trucks comprised only 28 percent of registered vehicles in the urban states, as compared to 52 percent in the rural states. Does this positive association between fatality rates and light truck registration indicate a light truck safety problem?

Before we can answer this question, we need to consider other factors that may be responsible for the higher rural fatality rate. Statistics show that travel in rural areas is more extensive, at higher speeds, and on less safe roads than in urban areas. Concerns over these factors may, indeed, lead safety conscious rural drivers to purchase light trucks because the vehicles' stiffer frames, higher ground clearance, and typically greater weight provide protection to their occupants in the event of an accident. Thus it could be that the higher percentage of fatalities in rural areas is causing an increase in light truck sales, contrary to NHTSA's claim that increased light truck use is causing an increase in fatalities.

ANALYZING THE DATA

TO UNRAVEL THE RELATIONSHIP BETWEEN LIGHT trucks and motor vehicle fatalities, we formulated a simultaneous equations model that considered the effect that light truck usage and other variables had on fatality rates over the period 1994 to 1997. (See *Regression Results* sidebar.) Using regression analysis, we initially tested for the effects of a standard set of independent variables that did not reflect the differences between rural and urban driving conditions. These variables included light truck registrations per licensed driver, amount of annual rainfall and snowfall, strength of state laws concerning seatbelt use and drunken driving, and the proportion of drivers in various age groups. As shown in the first two columns of Table 1, this analysis indicated a positive relationship between light truck registration and the motor vehicle fatality rate in both single-vehicle and multiple-vehicle accidents. This positive relationship could be interpreted to suggest that SUVs and light trucks are, indeed, contributing to the fatality rate.

We then carried out a second analysis that considered the effect of a number of rural-area variables that contribute to motor vehicle fatalities. These variables included the number of passenger miles traveled per registered dri-

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ver, the population per square mile, and the ratio of rural to urban miles. The results of this analysis are shown in the right two columns of Table 1. When these independent variables were included, we discovered that there is a negative relationship between light truck registration and the motor vehicle fatality rate in both single-vehicle and multiple-vehicle accidents. In other words, this second analysis—which controlled for rural factors—suggests that light trucks and SUVs are helping to lower the fatality rate.

The strong light truck effects in the case of single-vehicle fatalities imply that the stiffer frames and greater weights of light trucks are protective of life in collisions not involving other vehicles. Moreover, the light truck effects substantially offset any fatalities from increases in single-vehicle accidents associated with light truck use. The multiple-vehicle fatality equations imply that the protective effects of light trucks to their occupants outweigh any increase in fatalities associated with an increase in multiple-vehicle accidents due to light truck use and any increase in fatalities to occupants of other vehicles.

We further tested to determine what effect a specific type of light truck — the SUV — might have on the fatality rate. The results of this test are shown in Table 2. We found that, when examined individually, both SUVs and other light trucks have a negative relationship to traffic fatalities. Again, this suggests that the increasing number of SUVs and other light trucks are helping to lower the nation's motor vehicle fatality rate.

Finally, we tested our hypothesis that higher motor vehicle fatality rates increase people's preferences for light trucks and SUVs. The results of this test are shown in Table 3. Here, we found a positive relationship between these variables. This suggests that, indeed, people do seem to be more apt to purchase SUVs when the fatality rates in their area are high.

CONCLUSION

THE RESULTS OF THIS RESEARCH SUGGEST THAT THE increase in light truck use in the United States in recent years has helped to reduce motor vehicle fatalities. During the years of our sample period (1994-1997), light truck registrations per driver increased five percent. Our elasticity estimates indicate this increase consequently lowered single-vehicle fatalities per driver by 7.5 percent and multiple-vehicle fatalities per driver by two percent. These figures translate into about 2,000 lives saved between 1994 and 1997 because of the increase in light truck use.

Furthermore, the results indicate that light truck safety is a key determinant of light truck demand. With respect to the latter point, our research shows that light truck demand across states is not only associated with motor vehicle fatalities, but also with educational attainment. That is, the more educated a driver is, the more likely he is to drive an SUV or other light truck. Several studies have shown that education is the most important predictor of the demand for health. Its significance in the light truck demand equations is further evidence of the importance of safety in light truck demand. R

PREFERRED ON ROUGH TERRAIN:
Ford Ranger pickup in the desert

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Regression Results

TO DETERMINE THE RELATIONSHIP BETWEEN light truck use and roadway fatalities, we estimated the model using state level data for the four years, 1994 through 1997. There are three equations and one identity. Endogenous variables, or variables determined within the model, are marked. Separate equations for single- and multiple-vehicle fatalities are specified because of the aforementioned concerns over light truck rollover accidents and light truck "aggressiveness" when in accidents with cars.

In Table 1, the right-side exogenous variables in the equations in the left two columns are standard in the highway safety literature. (See, for example, Theodore E. Keeler's "Highway Safety, Economic Behavior, and Driving Enforcement.") Researchers have found motor vehicle fatalities to be inversely related to education levels, seatbelt laws, and drunken driving enforcement. Fatalities have been found to be positively related to miles traveled, the ratio of rural to urban miles traveled, inclement weather, young drivers, suicide, and to the average speed of travel.

To illustrate the importance of estimating a fully specified model of light truck demand and motor vehicle fatalities, we first present results that do not take account of rural variables or safety-induced demand effects. In Table 1, ordinary least square estimates in the left two columns are presented with independent variables excluded that are strongly associated with rural state locations. These excluded variables are population per square mile, the ratio of urban to rural miles traveled, vehicle miles traveled per driver, and the suicide rate. Without rural state controls, light trucks per driver are positively and significantly associated with motor vehicle fatalities, as might be anticipated given the findings of the NHTSA and the Insurance Institute. With the rural state correlates included, the light truck variable is negatively related to the fatality variables, but the coefficients are small. This is shown in the right two columns of Table 1.

The simultaneous equation estimates of the fatality equations are presented in Table 2. The estimation method is two-stage least squares. In the first stage of this technique, endogenous variables in the model are regressed against all exogenous variables in the equation system. Predicted values for the endogenous variables are obtained from these estimates and used in the estimation of the structural equations specified above. The substitution of predicted values for the actual values of right-side endogenous variables purges the correlation of the endogenous variables with the equation error terms. This is neces-

Table 1

Variables in Fatal Accidents

Results of regressing single- and multiple-vehicle fatalities per licensed driver in the United States, 1994-1997.

Independent variables for the state in which the accident occurred	ACCIDENTS: Not controlling for rural variables		Controlling for rural variables	
	Single-Vehicle	Multiple-Vehicle	Single-Vehicle	Multiple-Vehicle
Light truck and SUV registration per licensed driver	.0002 (7.2)	.00006 (3.1)	-.00003 (-1.1)	-.00006 (-2.2)
Dummy variable identifying states with 55 mph interstate highways	.00001 (2.3)	.0000036 (-.7)	-.00001 (-2.3)	-.00001 (-2.3)
Average inches of rain	.0000005 (.2)	.0000003 (2.5)	.0000003 (2.0)	.0000007 (4.5)
Inches of snow	.0000007 (-8.8)	.0000004 (-4.9)	.0000006 (-8.1)	.0000005 (-4.9)
Proportion of licensed drivers who are male and under 25 years of age	.0004 (1.4)	.001 (4.8)	.0007 (3.3)	.0005 (2.3)
Proportion of licensed drivers who are are over 60 years of age	-.0002 (-2.7)	.0001 (1.4)	-.0002 (-3.0)	.0001 (1.0)
Maximum fine for not wearing seat belt, first-offense	-.0000002 (-1.4)	-.0000003 (-1.8)	.00000007 (.6)	-.00000006 (-.5)
Dummy variable identifying states with no mandatory license suspension on first drunken driving offense	.00002 (4.6)	.000004 (1.5)	.00002 (6.1)	.00002 (4.0)
Proportion of persons 25 or older who hold four-year college degrees	-.0000003 (-5.1)	-.0000003 (-6.0)	-.00000003 (-.7)	.00000007 (-1.1)
Ratio of rural to urban passenger vehicle miles traveled			.00002 (5.8)	-.00000005 (-.02)
Population per square mile			.00000004 (5.0)	-.00000006 (-5.1)
Suicide rate per 100,000 people			.000008 (10.3)	.000001 (1.4)
Passenger vehicle miles per licensed driver			.009 (9.3)	.009 (8.9)
Constant	.0001 (4.0)	.00006 (2.2)	-.0001 (-3.7)	-.00003 (-1.1)
R^2 n	.72 200	.70 200	.86 200	.71 200

t statistics in parentheses

sary in order to obtain unbiased parameter estimates.

The structural equations must also meet identification criteria. A necessary condition for the identification and estimation of a structural equation in the system is that the number of exogenous variables excluded from the equation must be equal to or greater than the number of right-side endogenous variables. In our model of light truck demand and motor vehicle fatalities, the income variable appears in the demand equations but not in the fatality equations. The speed limit, seat belt and drunken driving penalty variables, and suicide rate variable appear in the fatality equations but not the demand equations.

Regressions 1 and 2 in Table 2, found in the left two columns, are second stage estimates of the fatality equations with the light trucks-per-driver variable endogenous. In regressions 3 and 4, found in the right two columns, second-stage estimates of the fatality equations are presented with the SUVs per driver variable endogenous. SUVs are considered separately because they are the fastest growing segment of the light truck industry.

Table 2 indicates that the light truck and SUV variables are negatively related to single- and multiple-vehicle fatalities. The light truck coefficients are 17 and two times larger in absolute value when equations 1 and 2 are estimat-

Table 2

Light Trucks and SUVs in Fatal Accidents

Results of regressing single- and multiple-vehicle fatalities per licensed driver in the United States, 1994-1997.

Independent variables for the state in which the accident occurred	ACCIDENTS: Light trucks, Single-Vehicle	Light trucks, Multiple-Vehicle	SUVs only, Single-Vehicle	SUVs only, Multiple-Vehicle
Light truck registration per licensed driver*	-.0005 (-3.6)	-.0001 (-1.6)		
SUV registration per licensed driver*			-.001 (-4.5)	-.0004 (-1.7)
Dummy variable identifying states with 55 mph interstate highways	-.00003 (-3.3)	.00001 (-2.1)	-.00002 (-2.7)	-.000008 (-1.9)
Average annual inches of rain	.0000006 (2.7)	.0000007 (6.0)	.0000003 (1.5)	.0000006 (5.3)
Inches of snow	-.0000006 (-4.9)	-.0000001 (-1.3)	-.0000005 (-5.2)	-.0000005 (-.6)
Proportion of licensed drivers who are male and under 25 years of age	.003 (4.2)	.0008 (2.9)	.001 (3.9)	.0005 (3.0)
Proportion of licensed drivers who are over 65 years of age	-.0004 (-3.2)	.0001 (1.5)	-.0005 (-4.7)	.0001 (1.2)
Maximum fine for not wearing seat belt, first-offense	-.00000001 (.5)	-.00000003 (-.3)	-.00000008 (-.6)	-.00000007 (-.7)
Dummy variable identifying states with no mandatory license suspension on first drunken driving offense	.00002 (2.6)	.000009 (2.7)	.0002 (4.5)	.00001 (2.9)
Proportion of persons 25 or older who hold four-year college degrees	.0000003 (3.4)	-.00000009 (-1.4)	-.0000003 (4.5)	-.0000001 (-1.6)
Ratio of rural to urban passenger vehicle miles traveled	.00004 (5.5)	.000003 (.6)	.00003 (7.6)	-.000003 (-.9)
Population per square mile	.00000007 (4.6)	-.00000003 (-3.6)	.00000008 (6.2)	-.00000002 (-2.6)
Suicide rate per 100,000 people	.00001 (6.9)	.000004 (2.7)	.00001 (9.3)	.000003 (2.9)
Passenger vehicle miles per licensed driver	.01 (5.7)	.01 (6.8)	.01 (7.4)	.01 (10.7)
Constant	-.0004 (-3.6)	-.0001 (-1.6)	-.0002 (-4.5)	-.00008 (-2.8)
R^2 n	.64 200	.80 200	.79 200	.82 200

* denotes endogenous variable   t statistics in parentheses   Observations weighted by the inverse of the state-specific standard deviation of the residuals to correct for heteroscedasticity.

ed in the simultaneous equations system that takes into account the effects of motor vehicle fatalities on light truck demand.

The elasticities at the means of single- and of multiple-vehicle fatalities per driver with respect to light trucks per driver are -1.5 and -0.4. The elasticities, when SUVs per driver is the light truck variable, are -0.6 and -0.3. (The elasticity is the percentage change in the dependent variable that results from a one-percent change in an independent variable. The elasticity at the means can be calculated by multiplying an independent variable's regression coefficient by the ratio of the mean of the independent variable to the mean of the dependent variable.) The t values of the light truck coefficient and the SUV coefficient in the single-vehicle fatality models are -3.6 and -4.5. The t values for these coefficients in the multiple-vehicle fatality models are -1.6 and -1.7.

In Crandall and Graham's widely cited report "The Effects of Fuel Economy Standards on Automobile Safety," the elasticity estimates of highway fatality rates with respect to vehicle weight ranged from -3.0 to -3.8. Our elasticity estimates indicate a 10-percent increase in light truck registrations would reduce single-vehicle fatalities by 15 percent and multiple-vehicle fatalities by four percent. Because single and multiple vehicle fatalities are roughly equal in number, overall fatalities would fall by about 10 percent ((15 + 4) ÷ 2). If we assume vehicle weight drives the light truck safety effect, our elasticity estimates are similar to Crandall and Graham's. In the sample period of this study, from 1994 to 1997, the average weight of light trucks was about 4,000 pounds and the average weight of cars about 3,000 pounds. Therefore, a 10-percent increase in light truck registrations would increase the average weight of the car and light truck fleet by about three percent. A three-percent increase in vehicle weight would reduce fatalities by 10 percent, given the assumptions above.

Light truck and SUV demand estimates are presented in Table 3. Fatalities per driver effects are large and consistent with the hypothesis that the added protection from motor vehicle fatality provided by light truck use is an important determinant of light truck demand. The elasticities at the means of light trucks per driver and of SUVs per driver to fatalities per driver are 1.0 and 1.8.

Those analyses indicate that, contrary to former NHTSA chief Martinez's claim, if light trucks replaced more cars on the nation's roads, the roadway fatality rate would decline further. Fortunately, America's motorists recognize this and are buying lights trucks and SUVs. R

Table 3

Do Fatality Rates Contribute to Increased Light Truck Sales?

Results of regressing light trucks and SUVs per driver on motor vehicle fatalities per licensed driver and other variables, 1994-1997.

Independent variables for the state in which the accident occurred	Light Trucks	SUVs
Total fatalities in vehicle accidents*	1450.0 (6.7)	533.0 (8.4)
Median income for four-member family	.000009 (5.4)	.000004 (6.8)
Average annual inches of rain	-.001 (-2.4)	-.0007 (-5.2)
Inches of snow	.001 (3.4)	.0007 (6.2)
Proportion of licensed drivers who are male and under 25 years of age	1.7 (2.4)	.09 (.4)
Proportion of persons 25 or older who hold four-year college degrees	.0005 (2.2)	.0002 (3.8)
Ratio of rural to urban passenger vehicle miles traveled	.05 (4.7)	.003 (1.1)
Population per square mile	-.0001 (-2.0)	-.000004 (-.3)
Passenger vehicle miles per licensed driver	-4.3 (-.08)	-5.6 (-3.5)
Constant	-.61 (-5.1)	-.21 (-5.8)
R^2	.67	.50
n	200	200

* denotes endogenous variable. t statistics in parentheses Observations weighted by the inverse of the state-specific standard deviation of the residuals to correct for heteroscedasticity.

READINGS

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