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Relationships between Vehicle Size and Fatality Risk in Model Year 1985-93 Passenger Cars and Light Trucks

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16. Abstract

Fatality rates per million exposure years are computed by make, model and model year, based on the crash experience of model year 1985-93 passenger cars and light trucks (pickups, vans and sport utility vehicles) in the United States during calendar years 1989-93. Regression analyses calibrate the relationship between curb weight and the fatality rate, adjusting for the effects of driver age, sex and other confounding factors. The analyses estimate the change in fatalities (including occupants of the "case" vehicle, occupants of other vehicles in the crash, and pedestrians/bicyclists) per 100 pound weight reduction in cars or in light trucks. A 100-pound reduction in the average weight of passenger cars, with accompanying reductions (based on historical patterns) in other size parameters such as track width, and in the absence of any compensatory improvements in safety technology, is associated with an estimated increase of 302 fatalities per year (± 3-sigma confidence bounds range from an increase of 170 to an increase of 434). However, a 100-pound reduction in the average weight of light trucks is associated with an estimated decrease of 40 fatalities (± 3-sigma confidence bounds range from a decrease of 130 to an increase of 50). In car-light truck collisions, 80 percent of the fatalities are occupants of the cars. When light trucks are reduced in weight and size, they become less hazardous to occupants of passenger cars as well as pedestrians, bicyclists and motorcyclists. Conversely, growth in the weight and size of light trucks could increase hazards to those groups.

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TABLE OF CONTENTS

The analyses are based on accident data from the 1989-93 Fatal Accident Reporting System (FARS) and vehicle registration data from R.L. Polk's *National Vehicle Population Profiles* for 1989-93. Fatality rates per million exposure years (which include fatalities to occupants of all vehicles in the crash, plus any pedestrians) are computed by make, model and model year. Regression analyses calibrate the relationship between curb weight and the fatality rate, adjusting for the effects of driver age and sex, vehicle age, State, urban-rural, daytime-nighttime and other confounding factors. Information about the age of the "average" driver in each make-model, and many of the other control variables, is derived from 11 State accident files for 1989-93, based on crash involvements in which vehicles were standing still (waiting for traffic to clear or a green light) and got hit by somebody else. The regression analyses estimate the percentage increase or decrease in fatalities (including occupants of other vehicles and pedestrians) per 100 pound weight reduction in cars or in light trucks. The percentage changes are applied to the 1993 "baseline" fatalities to estimate the absolute effects.

The estimates indicate what might happen to fatalities if **historical** relationships are maintained between weight and other size parameters, such as track width, wheelbase, center-of-gravity height, and structural strength. The trends shown here are not necessarily what would happen if a specific vehicle were reduced only in weight while keeping all other vehicle characteristics the same or if there were radical changes in the materials or design of vehicles. Specifically, the effect of weight reductions on fatalities in passenger car rollovers might be smaller if weight could be reduced without changing track width. If all **passenger cars** on the road were reduced in weight by 100 pounds, while light trucks and other vehicles remained unchanged, and in the absence of any compensatory improvements in safety technology, the following effects on fatalities are estimated:

PASSENGER CARS: EFFECT OF 100 POUND WEIGHT REDUCTION
(light truck weights unchanged)

Crash Type	Fatalities in 1993 Crashes	Effect of 100 Pound Weight Reduction	Net Fatality Change
Principal rollover	1754	+ 4.58%	+ 80
Hit object	7456	+ 1.12%	+ 84
Hit ped/bike/motorcycle	4206	- .46%	- 19
Hit big truck	2648	+ 1.40%	+ 37
Hit another car	5025	- .62% (nonsignificant)	- 31
Hit light truck	5751	+ 2.63%	+ 151
OVERALL	26840	**+ 1.13%**	**+ 302**
±2-sigma confidence bounds			**+214 to +390**
±3-sigma confidence bounds			**+170 to +434**

EXECUTIVE SUMMARY

Large vehicles have historically been more stable and provided more protection for their occupants than small ones, although those benefits to society might be offset if they present a greater hazard to other road users. Between 1975 and 1985, new passenger cars in the United States became twice as fuel-efficient, but their average curb weight dropped by nearly 1000 pounds, with corresponding reductions in other size parameters such as track width and wheelbase. During 1990-91, the National Highway Traffic Safety Administration (NHTSA) studied the safety effect of that weight and size reduction and concluded that it increased fatalities by nearly 2000 per year.

Between 1985 and 1993, the number of passenger cars on the road and their average weight remained quite stable, but the population of light trucks - pickup trucks, sport utility vehicles (SUV) and vans - increased by 50 percent, while the average weight of a new light truck increased by 340 pounds. By 1992, the number of fatalities in collisions between cars and light trucks exceeded the number in car-to-car collisions. In car-light truck collisions, 80 percent of the fatalities are occupants of the cars. That raises the question whether the growth in the number and weight of light trucks is having an adverse impact on the safety of passenger car occupants and other road users, possibly exceeding any safety benefits of the vehicle-weight increases for the occupants of the trucks.

The objective of this report is to estimate the relationship between curb weight and the fatality risk, per million vehicle exposure years, for model year 1985-93 passenger cars and light trucks, based on their crash experience in the United States from 1989 through 1993. "Fatality risk" includes all fatalities in the crash: not just the occupants of the "case" vehicle, but also the occupants of other motor vehicles, pedestrians, and bicyclists. In other words, the objective is to find the net effect on society, when vehicle weight is changed. Estimates are obtained for six fundamental crash types that, together, comprise most of the fatalities in the United States:

- Principal rollovers (not resulting from a collision)
- Collisions with objects (e.g., impacts with trees)
- Collisions with pedestrians, bicycles, or motorcycles
- Collisions with trucks over 10,000 pounds (Gross Vehicle Weight)
- Collisions with passenger cars
- Collisions with light trucks (pickups, SUVs, or vans)

The results for light trucks are new, while the findings for passenger cars are a completion and update of NHTSA's 1991 study. The principal reason for analyzing cars again is that NHTSA's 1991 analysis did not address three types of fatal collisions: those with pedestrians, big trucks and light trucks. Also, the safety environment has changed since the mid-1980's: more light trucks on the road, higher belt use, more female and older drivers. Because the analysis has been expanded to include all the major crash types, the results of this report supersede the 1991 findings for passenger cars. In view of the complexity and the high public interest in the issue of vehicle size and safety, a draft of this report was peer-reviewed by a panel of experts under the auspices of the Transportation Research Board of the National Academy of Sciences. The report was then revised in response to the panel's recommendations.

The effect of downsizing passenger cars would be a statistically significant increase of fatalities in rollovers, collisions with objects, big trucks, and above all, light trucks. The harm would be only slightly offset by a modest benefit for pedestrians, bicyclists and motorcyclists. The observed effect on fatalities in car-to-car collisions, if both cars in the collision were downsized, is not statistically significant. The largest relative increase, 4.58 percent, would be in rollovers, given the historical tendency that reduced mass means narrower, shorter, less stable cars. But the greatest absolute increase, 151 fatalities, would be in collisions between cars and light trucks, which were a much bigger safety problem in "baseline" 1993 (5,751 fatalities) than principal rollovers (1,754 fatalities).

Overall, a 100-pound reduction in the average weight of passenger cars, in the absence of any compensatory safety improvements, is estimated to result in 302 additional fatalities: a 1.13 percent increase over the baseline. This overall increase is statistically significant. Its 2-sigma confidence bounds range from 214 to 390. Two-sigma confidence bounds have been considered wide enough to include the likely range of error in past NHTSA evaluations. Given this evaluation's complex analysis approach, it might be appropriate to consider wider, 3-sigma confidence bounds. They range from 170 to 434. Either set of confidence bounds supports a conclusion that car weight reductions, given historical patterns of car design, would be associated with increases in fatalities. The current estimate is higher than NHTSA's 1991 study (approximately 200 lives per 100 pounds) because the 1991 study did not address collisions of cars with light trucks, big trucks and pedestrians.

If all **light trucks** on the road were reduced in weight by 100 pounds, while passenger cars and other vehicles remained unchanged, and in the absence of any compensatory improvements in safety technology, the following effects on fatalities are estimated:

LIGHT TRUCKS: EFFECT OF 100 POUND WEIGHT REDUCTION
(car weights unchanged)

Crash Type	Fatalities in 1993 Crashes	Effect of 100 Pound Weight Reduction	Net Fatality Change
Principal rollover	1860	+ .81% (nonsignificant)	+ 15
Hit object	3263	+ 1.44%	+ 47
Hit ped/bike/motorcycle	2217	- 2.03%	- 45
Hit big truck	1111	+ 2.63%	+ 29
Hit passenger car	5751	- 1.39%	- 80
Hit another light truck	1110	- .54% (nonsignificant)	- 6
OVERALL	15312	**- .26%**	**- 40**
±2-sigma confidence bounds			**-100 to +20**
±3-sigma confidence bounds			**-130 to +50**

Reducing the mass of light trucks would significantly increase the fatality risk of their occupants in collisions with objects and big trucks. But downsizing of light trucks would significantly reduce harm to pedestrians, motorcyclists and, above all, passenger car occupants. There would be little effect on rollovers because, historically, there has been little correlation between the mass of light trucks and their rollover stability (width relative to center-of-gravity height). There would also be little change in collisions between two light trucks, if both trucks are reduced in mass.

Even though the effect of mass reductions is statistically significant in four of the six types of crashes, the net effect for all types of crashes combined is small, because some of the individual effects are positive and others are negative. The benefits of truck downsizing for pedestrians and car occupants could more than offset the fatality increase for light truck occupants. It is estimated that a 100-pound reduction could result in a modest net benefit to society, a savings of 40 lives, (0.26 percent of baseline fatalities). However, this point estimate is not statistically significant: the 2-sigma confidence bounds range from a savings of 100 to an increase of 20 fatalities; the 3-sigma bounds range from a savings of 130 to an increase of 50 fatalities. It is concluded that a reduction in the weight of light trucks would have a negligible overall effect on safety, but if there is an effect, it is most likely a modest **reduction** of fatalities.

The results have a clear pattern: reducing a vehicle's weight increases net risk in collisions with substantially larger and stronger entities, **reduces** net risk in collisions with much smaller and more vulnerable entities, and has little effect on net risk in collisions with vehicles of about the same size. The only entities smaller than passenger cars are pedestrians, bicyclists and motorcyclists. Therefore, when car weight is reduced, the modest benefit for pedestrians is far outweighed by the increase in most other types of crashes. The latest light trucks, on the average, weigh over 900 pounds more than passenger cars. Continued growth in the number and weight of light trucks is likely to increase the hazard in collisions between the trucks and smaller road users (cars, motorcyclists, bicyclists and pedestrians), while a reduction in the weight of the trucks is likely to reduce harm in such collisions.

Some people believe that small cars attract aggressive drivers because they are more sporty and powerful than large cars. They might argue that, to a greater or lesser extent, it's not the cars, but rather their drivers that are responsible for the higher fatality rates of small cars in the preceding analyses. This belief may have been valid at one time, but today, the typical small car is no longer a sports car. The make-models currently associated with high performance, high horsepower, or aggressive driving are generally not small, but are of average or even slightly heavier-than-average weight. As a result, the high-performance make-models, if anything, biased the preceding analyses in favor of smaller cars. In a sensitivity test, the analyses of this report were re-run without those sporty and high-performance make-models. The correlation between passenger car weight and fatality risk did not diminish. In fact, it became slightly stronger. The predicted effect of a 100-pound weight reduction escalated from an increase of 302 fatalities in the baseline analysis to an increase of 370 fatalities on the sensitivity test.

CHAPTER 1

OBJECTIVES, BACKGROUND, ANALYSIS STRATEGIES AND DATA SOURCES

1.1 NHTSA's need to study size-safety relationships

A high proportion of the motoring public believes that large vehicles are safer than small ones. Ask people to describe a safe vehicle: some mention specific features such as safety belts or air bags, but others reply, "Show me the biggest car you've got [11], pp. 18-20." This belief is reinforced by intuition, personal experiences in two-vehicle collisions (the bigger car "didn't have a scratch"), and literature available to the public [4], [33]. The National Highway Traffic Safety Administration (NHTSA) has examined the size-safety issue a number of times **for passenger cars**. The latest study, dated 1991, confirmed that bigger cars are safer and estimated that "the reduction of the average weight of new cars from 3700 to 2700 pounds [during 1970-82] (or the associated reductions in car length and width) resulted in increases of nearly 2,000 fatalities and 20,000 serious injuries per year [7]."

Whereas large, heavy vehicles may provide excellent protection for their own occupants, their mass, momentum and structural strength could present a hazard to the occupants of lighter vehicles that collide with them. Between 1985 and 1993, the population of light trucks - pickups, sport utility vehicles (SUV) and vans - increased by 50 percent in the United States. Since the major downsizing of passenger cars, light trucks have had a substantial weight advantage over cars, and this advantage grew by an average of 240 pounds during 1985-93. By 1992, the number of fatalities in collisions between light trucks and cars exceeded the number in car-to-car collisions. That raises the question whether continued growth in the weight of light trucks would have an adverse impact on the safety of passenger car occupants and other road users, more than offsetting any benefits for the occupants of the light trucks, and possibly resulting in net harm to society.

Thus, the size-safety relationship may be quite different for passenger cars and light trucks. NHTSA's earlier size-safety studies only addressed passenger cars. Given the increasing proportion of light trucks, it is appropriate to study the size-safety relationsip for light trucks at this time (1995). But this is also a good time to recalibrate the relationship for passenger cars. Since NHTSA's last analyses, the driving environment has changed in the direction of higher use of safety belts and a higher proportion of older and female drivers. Moreover, NHTSA's 1991 analyses did not address the relationship between vehicle size and fatality risk, even for passenger cars, in three important crash modes: collisions with light trucks, big trucks and pedestrians.

The mission of this study is to calibrate the relationships between vehicle mass and **fatality** risk for the current (model years 1985-93 in calendar years 1989-93) fleets of light trucks and passenger cars, in the six principal crash modes: rollovers, and collisions with objects, pedestrians, big trucks, passenger cars, and light trucks. These relationships include the safety effects that are a direct consequence of changing mass, and the effects that are consequences of changing other vehicle size-related parameters (width, length, height, strength) that are intrinsically tied to mass. The calibration process should weed out the effects of other factors, especially nonvehicular factors such as driver age and sex, that are merely confounded with vehicle mass. One goal is to estimate the net effect on fatalities of a 100 pound reduction in the weight of light trucks; "fatalities" include pedestrians and occupants of other vehicles involved in the crashes, not just the occupants of the light trucks. The other goal is to obtain corresponding estimates for a 100 pound reduction in the weight of passenger cars. These estimates can be used to predict the net impact on fatalities from future weight changes, provided that current associations between vehicle mass and other size-related parameters (width, length, height, strength) stay about the same. The relationships between vehicle mass and the risk of nonfatal injuries is addressed in separate reports.

A draft of this report was completed in October 1995. Because of the complexity and the high public interest in the issue of vehicle size and safety, NHTSA arranged for a peer review of the draft report by a panel of experts under the auspices of the Transportation Research Board of the National Academy of Sciences. The panel completed its review in June 1996. The chairman, D. Warner North, submitted the panel's findings and recommendations in a letter, dated June 12, 1996, from the Transportation Research Board to Ricardo Martinez, M.D., the NHTSA Administrator. This report has been revised in response to the peer review, as follows: Chapter 5 of the draft has been split into two chapters, 5 and 6. The analyses that were added or modified in response to the peer review are documented in Chapter 6. Appendix F summarizes the panel's recommendations and the responses by the author of this report. However, except for the revisions and additions to address the peer review comments (primarily, but not exclusively, in Chapter 6 and Appendix F), the text of this final report is unchanged from the 1995 draft.

1.2 How vehicle size can affect safety

There are several intuitive reasons why heavier vehicles can be intrinsically expected to have different fatality risk than lighter vehicles. Most of these factors, but not all, favor the heavier vehicles. There are other, confounding factors that, superficially, make fatality rates of light and heavy vehicles different, but are not causally related to mass. For example, young drivers have high fatality rates and tend to drive smaller cars; their high risk, undoubtedly, would persist even if they all drove big cars. Finally, there may be some "in-between" factors with an indirect-causal relationship to mass.

Among the factors with a direct, physical relationship to mass, the best-known is that heavier vehicles have greater **momentum**. When a heavy and a light vehicle, travelling at the same speed, collide head-on, the heavy vehicle keeps moving forwards; its occupants experience a relatively low-severity collision with a small velocity change. The small vehicle gets pushed backwards; its occupants experience a severe collision with high velocity change. These are inevitable consequences of the laws of physics; nothing can be done to equalize the velocity changes. In a head-on collision of two cars, a 1 percent weight advantage corresponds to more than a 5 percent reduction in the driver's fatality risk, **relative to** the driver of the other car [16], p. 9.

What benefits an **individual**, however, doesnot necessarily benefit **society as a whole**, as will be seen throughout this study. Individuals who buy heavier vehicles reduce their own risk of dying in two-vehicle collisions, but increase that risk for occupants of the vehicles they collide with, possibly resulting in no net change in total fatalities in two-vehicle collisions. If one person buys a 10 percent heavier car, he gets a mass-ratio advantage, but if everybody else also buys 10 percent heavier cars, they cancel out his advantage. Based on momentum considerations in multivehicle collisions alone, society neither gains nor loses if the entire vehicle fleet experiences a proportional change in mass.

Momentum may provide a modest benefit in collisions between vehicles and "fixed" objects that are, in fact, slightly movable. A middling tree, for example, might completely stop a small car, but a heavier vehicle (especially a big light truck) might knock down the tree and keep rolling forwards.

Rollover stability is another area where the laws of physics favor one size of vehicle over another. Vehicles with a high "static stability factor" (wide track, low center of gravity) are less prone to rollover than those with a low stability factor (narrow track, high c.g.). But the relationship between vehicle mass and the static stability factor has historically been different in cars and light trucks. Much of the added mass in "big" passenger cars is used to increase their width and length (roominess and ride quality are selling points for big cars), but not their c.g. height (nobody wants to climb a ladder to get into a Cadillac). Thus, curb weight and the static stability factor have always been highly correlated in cars (although, conceivably, a moderate amount of weight could be removed from a car without reducing its track width). Big light trucks, on the other hand, are often tall or stand high off the ground. Added mass does not necessarily go into horizontal growth, but may go into vertical growth or into structures that do not change volume at all (four-wheel drive, heavy-duty carrying capacity). Curb weight and static stability are not strongly correlated in light trucks. For these reasons, rollover risk can be expected to have strong negative correlation with mass in passenger cars, but substantially lower correlation, if any, in light trucks.

Momentum is a **crashworthiness** factor (probability of fatality given a crash has occurred), whereas rollover stability is a **crash avoidance** factor (probability of a crash occurring, given some amount of on-the-road exposure). This study addresses the relationship between a vehicle's mass and its **overall** fatality risk per unit of exposure. The results will show the net combined effect of all mass-related crashworthiness **and** crash avoidance factors, and they will not single out whether mass is primarily affecting crashworthiness or crash avoidance.

Directional stability is a second crash avoidance factor that tends to favor bigger vehicles with longer wheelbases. A vehicle is directionally unstable if it tends to skid or spin out of control in response to braking or steering input or an uneven road surface. When a vehicle is out of control, it is liable to run off the road, hit a fixed object or roll over. The smallest light trucks have the greatest problem with directional stability.

There is a widespread perception that heavier vehicles have greater structural integrity than the lightest vehicles and provide better **protection against intrusion** by other vehicles or fixed objects. Doors, frames, pillars, roof rails, etc. are thicker and stronger. Since the occupant compartment is larger, these structures have more room to deform before they impinge on the occupants. Heavier cars and light trucks can be expected to have lower fatality risk in collisions with objects and big trucks, where intrusion often occurs.

Heavier vehicles may also offer better **built-in occupant protection** and cushioning in crashes. Their longer hoods and extra space in the occupant compartment provide an opportunity for a more gradual deceleration of the vehicle, and of the occupant within the vehicle. Crash tests in the New Car Assessment Program indicated that larger cars present a friendlier crash environment for belted occupants in frontal crashes [7]. It is unknown if similar trends exist for light trucks, or for unbelted occupants of cars.

The preceding factors all worked to the advantage of larger vehicles. There is one crash-avoidance and one crashworthiness factor that make smaller vehicles safer in certain types of crashes. Small vehicles, although they are less stable, appear to have greater **maneuverability**. It is unknown whether this is due primarily to physical factors or driver-vehicle interaction. Light weight and short wheelbases may actually speed up the vehicle's response to steering input. In addition, drivers appear to believe that small vehicles are easier to steer, and they are more likely to execute evasive maneuvers. That may help them avoid impacts with pedestrians and, perhaps, with other vehicles.

The larger cars and, especially, light trucks are believed to be highly **aggressive** and sometimes **incompatible** with smaller vehicles on the road. They have an exceptional ability to damage the smaller vehicle, even beyond what might be expected, given their superior momentum and structural strength. Their sills are high above the ground and have a tendency to ride over the sills of smaller vehicles with damage to the occupant compartment. Similarly, the high, flat front of these trucks may be aggressive to pedestrians. An increase in the weight and size of light trucks might do more harm to car occupants and pedestrians than it does good for the occupants of the light trucks.

1.3 Factors that confound size-safety analyses

The most important confounding factor in size-safety analyses is that young drivers, on the average, drive substantially lighter cars and trucks than older drivers, and females drive lighter vehicles than males. Driver age and gender are both highly correlated with fatality risk. Size-safety analyses must control for age and gender, otherwise, they will attribute safety problems to small vehicles that are actually due to the young drivers who use those vehicles.

The relationship between age, gender and fatality risk is nonlinear, and it varies with the type of crash, because it is a composite of at least four factors:

- **Annual mileage** is highest for drivers in the 20-50 age group and is fairly constant within that group. Mileage drops steadily after age 50 and before 20. Women drive less than men [6], pp. 15-16.

- **Intrinsic vulnerability to fatal injury** is lowest at age 20 and rises steadily thereafter, by 2.3 percent per year for males and 2 percent for females. At age 20, females are 30 percent more vulnerable than males, but by age 60, males and females are about equally vulnerable [9], pp. 22-28.

- **Driving imprecision or errors** that lead to crashes may proliferate due to inexperience, fatigue, alcohol, or a deterioration of physical capabilities and driving skills. Errors are frequently committed by young, inexperienced drivers; are least frequent from young adulthood until the beginning of middle age (ages 25-50); and steadily increase in frequency for older drivers.

- **Driving intensity or aggressiveness** is manifested by intentional driving near the limits of a vehicle's performance: high speeds, following vehicles closely, passing, turning left, or changing lanes when the space between vehicles is limited. Intense driving reduces the margin of error and increases accident risk. While it is difficult to quantify driving intensity, it is undoubtedly highest for young drivers and it decreases steadily with age; it has been higher for males than for females.

Most age-gender groups score high on some factors and low on others. For example, young males are high on mileage and intensity, but low on vulnerability. In general, though, drivers in the 30-50 age range have the lowest composite fatality risk.

A typical pattern of fatality risk by age and sex is shown in Figure 1-1 (which graphs the logarithm of the fatality rate relative to "induced-exposure" crashes in 11 States, based on methods developed in Chapter 2 of this report). The data points for males and females each come relatively close to an "asymmetric V with a flat base." The fatality risk for male drivers is reasonably constant between ages 35 and 50. Below age 35, the risk increases at a strong, almost linear rate as the drivers get younger. Above age 50, the risk also increases, but not as strongly. The fatality risk for female drivers is nearly constant between ages 35 and 45, and it is well below the risk for males. Below age 35, the risk increases in a manner similar to the pattern for males. A straight line, parallel to the line for males, fits the data reasonably well. At the higher ages, however, the risk for females catches up with the risk for males. The right part of the "V" for females has a steeper slope than for males, and it starts sooner (45 rather than 50).

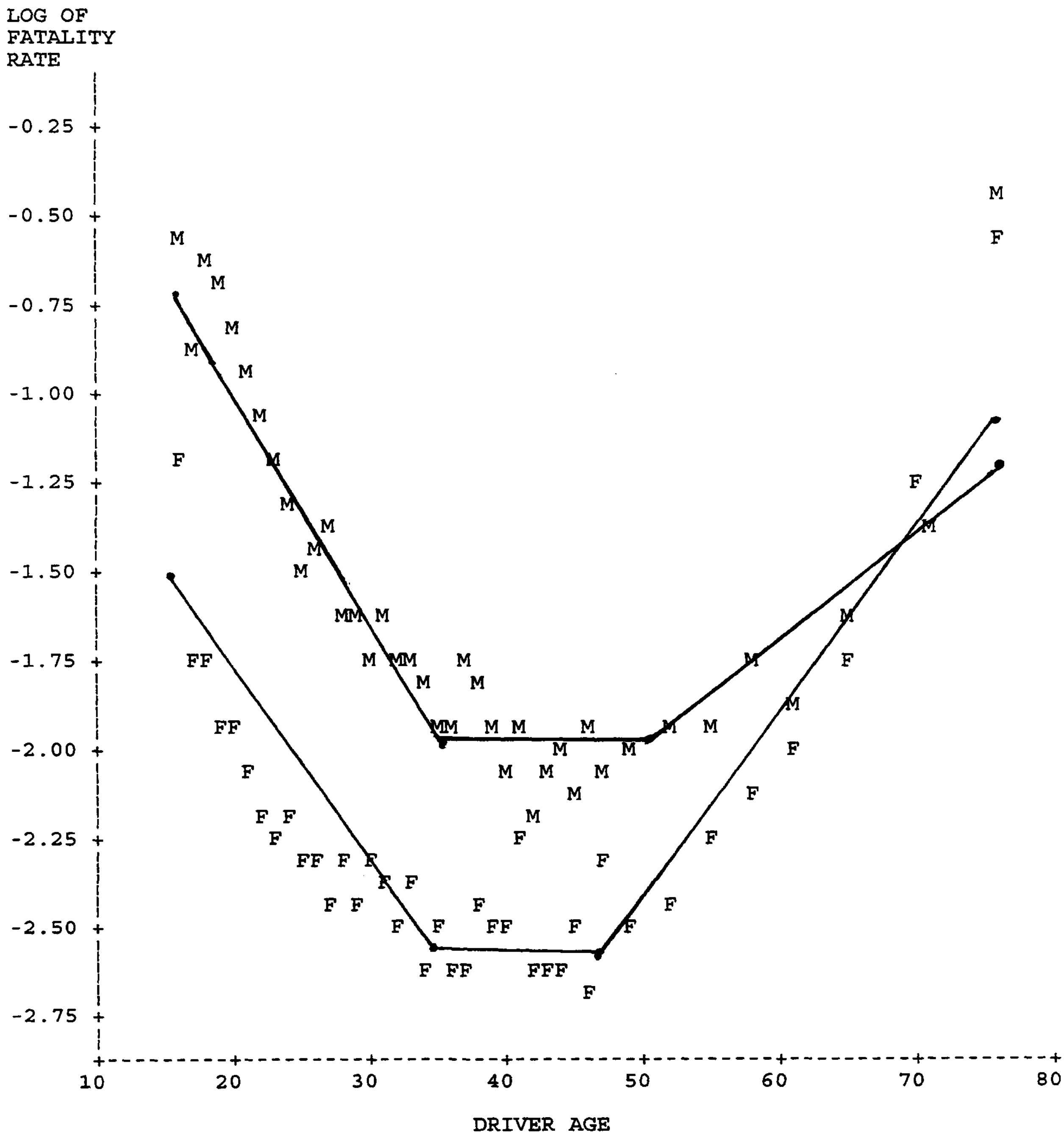
The relationship varies by crash mode. Rollovers are typically associated with intense driving, and they are prevalent among young drivers. The left side of the "V" is especially steep, while the right side (the portion for older drivers) is flat or might even point downwards. Analyses of rollovers that do not control for driver age are strongly biased in favor of the larger vehicles, which tend to have older drivers. Even intense drivers, on the other hand, keep a respectful distance from big trucks. These impacts are more likely to result from unintentional driving errors, and they are a major problem with older drivers, not young drivers. The "V" is steeper on the right than on the left. Analyses of collisions of passenger cars with big trucks that do not control for the age of the car driver are actually biased **against** the larger cars, which tend to have older drivers.

Geographical region is a confounding factor that may result in a bias against the larger vehicles. The heavily urbanized northeastern and Pacific States have low fatality rates and an abundance of small cars and trucks, while the southern and interior western States have higher fatality rates

FIGURE 1-1

LOGARITHM OF THE FATALITY RATE, BY DRIVER AGE AND SEX

(M = male, F = female)



and, on the average, somewhat larger vehicles.

Some vehicle design features are slightly confounded with car size and also have a direct or indirect relationship with fatality risk. For example, air bags reduce fatality risk in frontal crashes and, initially, were more likely to be installed in large than in small cars. Sport-utility vehicles (SUV) attract more intense drivers than vans, and they tend to be lighter than vans, on the average. Other vehicle design features include ABS, type of drive train and car body type.

Driving intensity and imprecision vary from one individual to the next, and they even vary over time for the same individual. Intensity is generally higher for young males, at night, on high-speed roads, and for two-door cars and SUV. But, of course, not all young males drive intensely, nor are all older drivers error-prone, etc.

It is well-known that certain make-models of passenger cars and light trucks attract innately aggressive drivers and/or perhaps even stimulate average drivers to drive more intensely than usual. Those models include sporty cars - convertibles, two-seaters and high-horsepower two-door coupes - and certain Sport Utility Vehicles. There is a widely-held view that the "typical" light car is sporty, and vice-versa, and that, as a consequence, the higher fatality rates of light cars are really because they are sporty or high-performance, not because they are light. (For example, the peer-review report states on p. 5, "Insofar as more aggressive drivers tend to drive smaller cars...the effect of aggressiveness is incorrectly incorporated into the estimated effect of weight--such that reductions in weight appear to have a greater impact on fatalities than is in fact true.") In fact, most of the sporty or high-performance vehicles with reasonably high sales volumes are somewhat **heavier** than the average vehicle on the road. Thus, as we shall see in the sensitivity tests of Section 6.5, the "sports/high performance" factor is actually a modest bias **against heavier cars**, not against light cars.

Vehicle age and calendar year may interact with fatality risk. In general, older vehicles have fewer fatalities per year, but more per mile (they are driven less). Some calendar years, such as 1992, are safer than others for all vehicles. If, as in the case of light trucks, average mass is changing over time, there may also be interactions of mass with vehicle age and calendar year, possibly biasing the analyses.

1.4 Analysis strategies and data sources

The ideal measure of risk is the number of fatalities **per 100 million miles**, adjusted for driver age, sex, and the other confounding factors described above. Another measure, the number of fatalities per 100 reported crashes, is less desirable. It does not address crash avoidance capabilities, but only the risk of a fatality given that a crash has occurred. Vehicle A might be safer than Vehicle B because it has fewer crashes, even though both vehicles have the same fatality rate per 100 crashes. Specifically, large cars have far fewer rollovers per million miles than small cars, but the fatality risk per 100 rollovers is about the same, or even higher in the large cars.

The fatality risk per 100 reported crashes can also be biased by vehicle-to-vehicle differences in crash reporting. To begin with, the legal threshold for crash reporting is typically a specific dollar amount of damage. Vehicles with expensive parts (large cars) are more likely to have damage in excess of the threshold than vehicles with inexpensive parts (small cars). Secondly, the same impact can result in different extents of damage on different vehicles. An impact that trivially dents a rugged pickup truck, and goes unreported, might have disabled a small, light car. Finally, there is a motivation to avoid the paperwork and other burdens of crash reporting. Many borderline-reportable crashes go unreported. Intuitively, it seems that reporting rates will be lower when owners are less fastidious about their vehicles - e.g., when they are no longer brand-new. The net result is that large, elegant, expensive vehicles, such as brand-new luxury cars, may have high reporting rates for low-level crashes, and, as a result, few fatalities per 100 reported crashes. Large, rugged, utilitarian vehicles, such as five-year-old full-sized pickup trucks, may have relatively few reported low-level crashes. Since the crashes that <u>are</u> reported are, on the average, fairly severe, the fatality rate per 100 reported crashes is high.

The ideal measure of risk being fatalities per 100 million miles, the ideal data base ought to include every mile traveled by every vehicle in the United States. Every mile negotiated without a fatal crash would constitute a "success" and every fatal crash involvement would be a "failure." The mass of the vehicle, the age and sex of the driver, the time of day, the highway speed limit, etc., would be known for every fatal crash and for every successfully negotiated vehicle mile. A logistic regression analysis would calibrate the ratio of "failures" to "successes" as a function of vehicle mass, driver age and sex, etc. The regression equation makes it possible to estimate the fatality risk per 100 million miles, as a function of vehicle mass, if all other factors are held constant.

Of course, the ideal data base does not exist. There is no national census of the annual mileage driven by individual vehicles, let alone the characteristics of individual miles (age and sex of driver, time of day, etc.). A possible substitute for a census of miles would be an exposure data base: a probability sample of vehicle sightings on the nation's roads, specifying the make-model of the vehicle, the age and sex of the driver at the time the vehicle was sighted, the time of day, type of roadway, etc. While an exposure data base is at least theoretically obtainable, none is currently available or planned.

Since analyses of fatalities per 100 million miles are not feasible, another measure of risk must be selected. Fatalities **per million vehicle years**, at first glance, are an acceptable substitute. R. L. Polk's *National Vehicle Population Profile* is a census of cars and light trucks registered in the United States, classified by make-model, model year, registration State, and some other vehicle parameters [26]. In combination with fatal accident data, it is possible to compute fatality rates by make-model and, ultimately, by vehicle weight. Polk data, however, provide no information about the age or gender of vehicle owners. Even if they did, the information would be of little value, since the owner is not necessarily the driver. Intuitively, vehicle miles can readily be classified by driver age and sex, time of day and roadway type; vehicle years cannot. That makes it impossible to perform a logistic regression analysis of "failures" (fatal crash involvements) and "successes" (vehicle years without a fatal crash involvement) as a function of vehicle mass, driver age and sex, etc. Any information on driver age and sex, for vehicles not involved in fatal crashes, would have to come from a data source other than Polk, and it would be in the form of averages at the make-model level, not data on individual vehicles.

The two preceding methods were based on direct measures of exposure: vehicle miles or vehicle years. A third method uses **"induced exposure"** as a surrogate for vehicle miles or years. Units of induced exposure are crash involvements: typically, involvements as a nonculpable vehicle in a multivehicle collision [5] (or, more narrowly, a vehicle that was standing still and got hit by somebody else). The rationale is that such a vehicle did nothing to bring about the collision, but got involved in the collision merely because "it was there." These involvements are said to be a surrogate for exposure, because they measure how often a vehicle "is there" where it can be hit by other vehicles. A vehicle driven 20,000 miles per year should have twice as many induced exposure crashes as a vehicle driven 10,000 miles per year under similar conditions.

The great advantage of the induced-exposure method is that the units of exposure are crash involvements. The age and sex of the driver, the time of day and roadway type are all known. Logistic regression can be applied directly, with fatal involvements defined as "failures" and induced-exposure crash involvements defined as "successes." The regression equation makes it possible to estimate the fatality risk per 100 induced-exposure crashes, as a function of vehicle mass, if all other factors are held constant.

Nevertheless, the induced-exposure method has critical flaws. The induced-exposure crash rate is highly sensitive to many factors other than a vehicle's mileage. Specifically, it depends on the density of traffic where the vehicle is operating. Manhattan taxicabs will have many induced-exposure crashes per million miles, and few fatalities per 100 induced-exposure crashes. Pickup trucks in rural Wyoming have few induced-exposure crashes per million miles, because there are so few other vehicles on the road to hit them, and many fatalities per 100 induced-exposure crashes. Even at a single location and time, the induced-exposure crash rate will vary from driver to driver. An aggressive young male driver will have few induced-exposure crashes per million miles because he rarely stands still long enough to get hit by somebody else.

Moreover, induced-exposure crashes, like any other kind of police-reported, nonfatal crashes, are subject to vehicle-to-vehicle differences in reporting rates. As noted above, large, rugged, utilitarian vehicles, such as big pickup trucks and vans, may have relatively few reported low-level crashes of any type, including induced-exposure crashes - and there is no way to estimate the extent of underreporting directly from the accident data. Finally, the "fatality rate per 100 induced-exposure crashes" is a somewhat artificial measure of risk, whereas the fatality rates per 100 million miles, or per million years, are natural measures that are much easier to visualize and explain.

In view of the preceding considerations, three separate analysis strategies will be pursued. Chapters 2 and 3 present logistic regression analyses of fatalities per 100 induced-exposure crashes, based on accident data from 11 States:

Florida	Illinois	Louisiana
Maryland	Michigan	Missouri
New Mexico	North Carolina	Ohio
Pennsylvania	Utah	

Those are the States whose accident files are available for analysis at NHTSA, and where the

Vehicle Identification Number (VIN) is reported on most vehicle records. The VIN is essential for correct identification of the make-model, the vehicle mass, body type, and other size parameters, safety features and equipment. These analyses will produce estimates of the relationships between vehicle mass and fatality risk per 100 induced-exposure crashes, but the estimates may be biased due to vehicle-to-vehicle differences in crash reporting, as described above.

Chapter 4, based on State accident data and Polk registration data for the preceding 11 States, calculates rates of induced-exposure crashes per 1000 vehicle years - initially by make-model and subsequently by vehicle weight. This analysis shows that the induced-exposure crash rate for **passenger cars** is nearly constant, as a function of vehicle weight, after the data are controlled for driver age and sex. However, the rate for **light trucks** significantly decreases as weight increases. In other words, the weight-safety analyses of Chapters 2 and 3 are significantly biased against the bigger light trucks.

In Chapters 5 and 6, Fatal Accident Reporting System (FARS) accident data [10] and Polk registration data for the entire United States are jointly analyzed to obtain fatality rates per million vehicle years - by make-model, model year and vehicle body type. As noted above, the Polk data say nothing about driver age and sex. However, the induced-exposure accident data for the 11 States provide information about the distribution of driver age and gender, as well as other parameters, by make-model, model year and vehicle body type. A regression analysis adjusts for driver age, sex and other confounding factors to obtain, hopefully, unbiased estimates of the residual relationships between vehicle weight and fatality risk per million years.

1.5 NHTSA's earlier size-safety studies

There have been numerous studies of the relationship between vehicle size and safety. Almost all of them focused on passenger cars, not light trucks. Almost all of them concluded that fatalities or injuries increase when mass is reduced. The National Research Council's comprehensive analysis of fuel economy issues reviewed the size-safety literature [2], pp. 47-68. As early as 1964, statistical analyses by Kihlberg, Narragon and Campbell showed a higher serious-injury risk per 100 reported crashes in small cars [22]. The energy crisis of 1973-74 spurred interest in the size-safety issue. The first statistical analysis at NHTSA was performed by Mela in 1974 [24]. He analyzed the driver's serious injury rate per 100 car-to-car crash involvements, and he found that the risk increased by 5 percent per 100 pound decrease in the weight of the driver's car, but decreased by 2 percent per 100 pound decrease in the weight of the other car. In 1984, Jones and Whitfield used logistic regression to analyze injury rates per 100 drivers, controlling for other variables such as age and sex [14]. Serious injury risk increased by 4.1 percent, per 100 pound weight reduction, for unrestrained drivers, and by 2.8 percent for belted drivers.

NHTSA's most recent size-safety analyses were performed in 1989-91. They include Mengert and Borener's analysis of fatal crashes, sponsored by NHTSA [25], and a group of studies by NHTSA staff that became the basis for the agency's position on the effect of passenger-car size on fatality and injury risk [7].

The Mengert-Borener Model comprehensively addresses the relationship between car size and fatality risk. The measure of risk, fatalities per million car years, accounts for crash-avoidance as well as crashworthiness effects. Separate analyses address four crash modes which, together, comprise essentially all fatal crashes involving cars: single-vehicle [rollover or fixed object], collision with pedestrian/bicyclist, collisions of two passenger cars, collision of car with another type of vehicle [light truck, heavy truck, motorcycle]. The data set included model year 1978-87 cars in calendar year 1978-87 FARS and Polk data. "Fatalities" included pedestrians and occupants of other vehicles as well as the car occupants.

Cars were subdivided into six weight groups (< 1950 pounds, 1950-2449 pounds, etc.). In the three crash modes involving a single passenger car, a relative fatality risk was obtained for each of the six weight groups: the proportion of the fatalities F_i in weight group i was divided by that weight group's proportion of car registrations R_i. For example, if cars in the lightest weight group account for $F_1 = 15$ percent of the single-vehicle crash fatalities and $R_1 = 10$ percent of car registrations, the relative risk is 1.5. In the car-to-car crash mode, the relative risk was obtained for each of the 36 pairs of weight groups: the proportion of car-to-car fatalities F_{ij} involving a car of weight group i and a car of group j was divided by $R_i R_j$. For example, if collisions between cars of the lightest weight group and the heaviest weight group account for $F_{16} = 1$ percent of car-to-car fatalities, $R_1 = 10$ percent and $R_6 = 5$ percent of car registrations, then the relative risk is 2.0. With these measures of relative risk, Mengert and Borener could estimate the net effect on total fatalities for **any** hypothetical future change in the distribution of car registrations among the six weight groups.

Their analysis did not adjust for driver age, sex, or any other factor that is confounded with vehicle mass and correlated with fatality risk. This was not as severe a shortcoming in analyses of cars of the early 1980's as it would be in analyses of recent vehicles, since driver age has become ever more confounded with vehicle weight [28].

If all passenger cars were to be reduced in weight by 100 pounds, while vehicles other than passenger cars remain unchanged, the Mengert-Borener model predicts the following effects, by crash mode, on overall fatalities (car occupants plus the other people involved in the crashes):

Crash Mode	**Effect of 100 Pound Reduction**
Single vehicle (rollover or fixed-object)	2.0 percent increase
Collision with pedestrian/bicyclist	2.4 percent reduction
Collision of two passenger cars	0.8 percent reduction
Collision of car with another type of vehicle	1.0 percent increase
All crash modes combined	0.5 percent increase

These results provided interesting revelations. The detrimental effects of weight reduction were confined to single-vehicle crashes and collisions with larger vehicles (light and heavy trucks). The net societal effect in two-car collisions was small: the harm to the occupants of the smaller car was offset by the benefit in the larger car. Lighter cars actually reduced collisions, or the fatality risk given a collision, with pedestrians and bicyclists. The combined effect for all the crash modes was an increase in fatalities, but proportionately less than many had feared.

Still, the results betray some anomalies. That a 100 pound reduction in car weight would **reduce** car-to-car fatalities is simply counterintuitive. The reduction of pedestrian fatalities seemed unreasonably large. Moreover, when the analyses were limited to FARS data later than 1983, the results shifted substantially in favor of larger cars. All of these anomalies could plausibly be attributed to the model's absence of control for driver age, sex, geographic region, etc. Thus, in 1990-91, NHTSA did not rely directly on these results for its final estimate of the effect of downsizing on fatalities. Nevertheless, Mengert and Borener offered original and efficacious concepts that animated the analyses of this report: they measured fatality risk per million vehicle years rather than per 100 crashes; they addressed all important crash modes individually, but by a uniform approach; and they included fatal injuries to people other than car occupants.

The rest of the analyses described here were performed during 1989-91 by NHTSA staff, and they were summarized in a 1991 document presenting NHTSA's conclusion on the overall effect of car size on safety [7]. The largest relative increase in fatalities was observed in Kahane's study of rollovers [17]. Frontal impacts with fixed objects were considered a control group: a measure of the exposure of a group of vehicles to run-off-road excursions. The number of rollover fatalities in a particular car size group was compared to the number of frontal fixed-object fatalities, to determine relative rollover risk. "Size groups" were established based on mass, track width, wheelbase, or a combination of those parameters. "Rollovers" included all most-harmful-event rollovers, even if the first harmful event was a collision with a fixed object or another vehicle. The study concluded that a fleet of model year 1970 cars, averaging 3700 pounds, would experience 3300 rollover fatalities per year, while a fleet of 1982 cars, averaging 2700 pounds, would experience 4640 fatalities. That corresponds to approximately a 3.5 percent fatality increase for every 100 pound weight reduction.

One weakness of the analysis is that frontal fixed-object crashes are a partially flawed control group. Ideally, the car's propensity to experience control group crashes should be completely unaffected by its propensity to roll over. That is not the case here: an unstable vehicle may have lower propensity to hit fixed objects than a stable vehicle, because it occasionally rolls over even before it reaches the fixed object. The analysis did not control for driver age or sex. The flawed control group and the absence of adjustment for age and sex bias the results in favor of large cars. On the other hand, Kahane assumed that fatality risk from fixed-object impacts does not vary substantially with car size. In fact, the risk decreases as cars get larger. To that extent, the model's measurement of rollovers relative to fixed-object impacts underestimates the absolute rollover-reducing benefit of large cars.

Partyka and Boehly investigated drivers' injury rates per 100 towaway crashes [29]. They used National Accident Sampling System (NASS) data from 1981-86 [27]. Moderate injuries (AIS $\geq$ 2) and serious injuries (AIS $\geq$ 3) were analyzed [1]. Injury rates **in single-vehicle nonrollover crashes** were computed in six car-weight classes and adjusted for differences in Delta V (crash severity), driver age and sex. Based on the trend of the adjusted rates across the six weight groups, the authors concluded that the risk of moderate injury in single-vehicle nonrollover crashes increases by 1.3 percent when car weight is reduced by 100 pounds. Since the measure of risk is injuries per 100 crashes, this model only calibrates the relationship between vehicle weight and crashworthiness; crash-avoidance effects are not considered. The NASS data set was too small for a statistical analysis of fatal injury risk.

Klein, Hertz and Borener employed logistic regression to calibrate drivers' injury risk per 100 towaway crashes, as a function of vehicle weight, driver age and sex, crash mode, and other variables, in 1984-87 Texas accident data and 1984-88 Maryland data [23]. They studied fatal injury rates and police-reported "serious" (K + A) injury rates in three crash modes: nonrollover single-vehicle (fixed-object) crashes, collisions between two cars, and collisions of a car with a heavy truck. If each passenger car in the collision is reduced by 100 pounds, but all other vehicles are unchanged, their models predict the following changes in risk:

	Effect of 100 Pound Reduction	
Crash Mode	**Fatalities**	**K+A Injuries**
Fixed object	0.9 percent increase	not analyzed
Car to car	nonsignificant	1.3 percent increase
Car to heavy truck	not analyzed	1.1 percent increase

Since the measure of risk is injuries per 100 crashes, the above estimates only take into account crashworthiness effects. The analyses confirm the Mengert-Borener finding that reducing the weight of **all** cars on the road has little effect on net fatalities in car-to-car crashes, but it will significantly increase nonfatal injuries in those crashes, and fatalities in impacts with fixed objects. It was concluded that downsizing the passenger car fleet from 3700 to 2700 pounds was associated with an increase of 633 fatalities per year in single-vehicle nonrollover crashes.

Based on the estimated annual increases of 1340 rollover fatalities and 633 single-vehicle nonrollover fatalities, the agency concluded that "the reduction of the average weight of new cars from 3700 to 2700 pounds (or the associated reductions in car length and width) resulted in increases of nearly 2,000 fatalities ... per year [7]." In relative terms, that amounts to 1.9 percent increase in single-vehicle crash fatalities (rollover plus nonrollover) per 100 pound reduction in car weight - or a 0.7 percent increase in **overall** fatality risk per 100 pound reduction in car weight. However, NHTSA's 1991 estimate is essentially based on an incomplete analysis since the relationship of car size with fatality risk was not studied for three important crash modes: collisions of cars with light trucks, heavy trucks and pedestrians.

CHAPTER 2

FATALITIES PER 1000 INDUCED-EXPOSURE CRASHES IN 11 STATES: DATA

2.1 Analysis objective

The overall mission of this study is to calibrate the fatality risk per unit of exposure, as a function of vehicle weight or size, controlling for confounding factors such as driver age, sex, etc. Exposure is usually measured in vehicle miles or vehicle years, but as explained in Section 1.4, the "induced-exposure" crash involvement can serve as a surrogate. In Chapters 2-4, an **induced-exposure involvement** is a vehicle that has been standing still for some time, for a legitimate reason (e.g., because of a red light, or waiting for traffic to clear so they can turn) and gets hit by somebody else. The struck vehicle did nothing to precipitate the collision, but got hit merely because "it was there." These involvements are a surrogate for exposure, because they measure how often a vehicle "is there" where it can be hit by other vehicles. Induced-exposure crashes are almost always nonfatal, and they are recorded on State accident files. The State data can provide basic information, such as the VIN of the vehicle, the age and sex of the driver, the time of day and roadway type. The Fatal Accident Reporting System (FARS) provides more detailed information about fatal crash involvements in the same States, allowing identification of the crash mode. Fatal involvements (in a particular crash mode) and induced-exposure involvements are assembled into a single data file. Logistic regression can be applied directly to this file, with fatal involvements defined as "failures" and induced-exposure crash involvements defined as "successes." The regression equation makes it possible to estimate the fatality risk per 100 induced-exposure crashes, as a function of vehicle mass, if all other factors are held constant.

The analysis methods described in Chapters 2-4 do not succeed in producing unbiased estimates of the relationship between vehicle weight and fatality risk, as we shall see later on in Chapters 3 and 4. Thus, the primary findings of this report are those of Chapters 5 and 6. The material in Chapters 2-4 is nevertheless useful because it provides coefficients for the relationship between driver age and fatality risk; these coefficients are used in the Chapter 5-6 analyses. Also, the Chapter 2-4 results, although displaying evident biases, do provide some confirmation for the findings of Chapters 5-6. Many of the working data sets used in Chapters 5 and 6 are defined here.

2.2 Vehicle classification and specifications

The prerequisite for the analysis is a procedure that identifies vehicles on State files and FARS in exactly the same way, and specifies the vehicles' mass and other characteristics. The Vehicle Identification Number (VIN) is the one vehicle identifier that has exactly the same meaning on FARS and on any State file that reports it. NHTSA has access to 11 State files that reported the VIN during all or part of 1989-93. A series of programs must be written that, based entirely on the VIN, identify a vehicle's make-model, model year and body type, and specify its weight and other characteristics. These programs are applied to FARS and State data in the same way.

The first program analyzes all VINs on the accident file and picks out model year 1985-93 passenger cars and light trucks with Gross Vehicle Weight (GVW) $\leq$ 10,000 pounds. "Light trucks" include pickup trucks, sport utility vehicles (SUV), vans and pickup-cars (such as El Camino). The selection is generally based on the first three (make) and the tenth (model year) characters of the VIN, assisted by the fourth character to identify the GVW of light trucks. Appendix A lists valid combinations of the first three VIN characters: those that were included in the study, and those that were excluded because they denoted heavy trucks and buses, motorcycles, All Terrain Vehicles, or vehicles with low sales volume.

The next set of programs decodes the first eight characters of the VINs to identify and classify specific vehicles. Each vehicle is assigned two four-digit codes: its fundamental car [or light truck] group (CG) and specific make-model (MM2). These codes replace any make-model information already on FARS or the State files. Appendix B lists each of the car groups and describes the VIN codes for each of their constituent make-models. Appendix C does the same for light trucks. The car groups were originally defined in NHTSA's evaluation of the New Car Assessment Program [16], while the light truck groups were defined especially for this study.

Each car or light truck group comprises one or more make-models sharing a body platform. For example, all GM N-body cars (Buick Somerset and Skylark, Olds Calais and Achieva, Pontiac Grand Am) belong to the same car group. When a car or truck gets a major redesign, a new group is defined - e.g. Honda Accord in 1990, or GM C/K pickups in 1988. Vehicles with a "shared body platform" belong to the same functional class (car, pickup, SUV or van) and usually have the same wheelbase, track width and primary drive system (front-wheel or rear-wheel). Different make-models in the same car group are sometimes nearly identical "corporate cousins" (Ford Tempo and Mercury Topaz, Dodge Caravan and Plymouth Voyager), or they may be recognizably different vehicles on the same platform (1985 Cadillac Seville and Eldorado, Nissan long-bed and King-Cab pickups).

The specific make-model codes for passenger cars generally, but not exactly, follow the pre-1991 FARS and NASS definitions. It should be noted that the same make-model code may be used for two quite different vehicles in two separate car groups, even in the same year: e.g., 1988 Buick LeSabre H-body sedan or a B-body station wagon.

The specific make-model codes for light trucks do not resemble the codes on FARS or NASS. They are much more detailed. To the extent that it can be deciphered from the VIN, each of the various forms of a truck gets a separate make-model code: basic cab, extended cab, 4x2, 4x4, etc. When two forms of a truck have different wheelbases, they will also be in separate light truck groups. For example, the Ford Ranger and Ranger 4x4 are models 7401 and 7402 in light truck group 7401; the Ranger Supercab and Ranger Supercab 4x4 are models 7427 and 7428 in light truck group 7410. However, for most domestic pickup trucks, the basic short-bed and long-bed models share the same first eight characters of the VIN, and have to be assigned the same make-model code.

Fewer than 10 percent of all light trucks, but somewhat more of the large pickups (series 250 and 350) and up to half of some of the large vans are sold as "incomplete vehicles," as evidenced by the third character of the VIN. An "incomplete" pickup truck is typically the manufacturer's cab and chassis, with a specialized body built by somebody else, and not described by the VIN. Since the weight and size of these bodies is unknown and may vary a lot, the relatively small number of "incomplete" pickups was usually excluded from the study. "Incomplete" vans, on the other hand, are more numerous, and many of them are camper conversions that are about the same size as the original models. In order to avoid excessive loss of data, most of them are included in the study. Appendix C notes exactly which incomplete vehicles are included and which are excluded: the same VIN definitions are used for the FARS and the State data, so the criteria for inclusion are consistent.

Cases with nonvalid VINs are deleted. To prevent excessive deletions, however, one set of "minor" errors in the VIN is permitted: if a field which must have a numeric code has alphabetic O the program "corrects" it to numeric 0; likewise I to 1, Z to 2, S to 5, G to 6 and B to 8 - and vice versa if look-alike numeric codes appear in an alphabetic field.

Another program analyzes passenger car VINs to define the body style (BOD2), which may have the following values: convertible; 2-door (including 3-door hatchback, 2-door station wagon); 4-door (including 5-door hatchback); station wagon (with 4 doors).

After identification and classification of the vehicles based on their VINs, the next task is to list their specifications: the curb weight (CURBWT) in pounds, the wheelbase (WHLBASE) and track width (TRAKWDTH) in inches, the type of drive train (DRVTRAIN) [RWD, FWD, 4WD], the air bag status (AIRBAG) [none, driver, dual], and the Antilock Brake System status (ABS) [none, rear-wheel, 4-wheel]. An additional specification for passenger cars is the engine displacement (CUBES) in cubic inches. For light trucks, additional variables are the truck type (TRKTYP) [compact pickup, full-sized pickup, compact SUV, full-sized SUV, compact van, full-sized van, pickup-car] and, for some pickups, the long-bed wheelbase (WHLBASE2).

The most accurate listings of curb weights for **passenger cars** are the official *Automobile Specifications* supplied by the manufacturers through the American Automobile Manufacturers Association (once called the Motor Vehicle Manufacturers Association, or MVMA). The books list the baseline curb weight of every make-model and subseries (level of decor) plus the incremental weight of each optional engine and other equipment. Data in these books have been accurately encoded in the tapes of R. L. Polk's *National Vehicle Population Profile* [26], which lists a curb weight for each combination of make, model year, subseries [SERS_ABR], body style, engine code and, possibly, fuel code. Based on software written for NHTSA's evaluation of the New Car Assessment Program, each combination of these Polk codes can be associated with a specific car group (CG), make-model (MM2), body type (BOD2) and model year (MY) [16], pp. 19-20. Registration-weighted averages of curb weight were computed by CG, MM2, BOD2 and MY and entered into a look-up table. (Some weights in the initial table looked obviously inaccurate. They were corrected based on the trend in earlier or later model years.) In other words, given a VIN, the classification programs define the CG, MM2, BOD2 and MY, and the look-up table defines the curb weight. The same procedure was used to define average engine displacement [CUBES].

Wheelbase and track width of cars are clearly specified in *Automotive News Market Data Books* [3], and they are equal for all cars in a car group. Information about the drive train, air bags and

ABS is also derived from these books, supplemented by VIN analyses and data in NHTSA evaluation reports [8], [20]. A combination of a look-up table and a VIN-analysis program assigns values for DRVTRAIN, AIRBAG and ABS to each car. Appendix D tabulates the curb weight, track width and wheelbase for 1985-93 passenger cars.

Curb weight information is not as readily available for **light trucks** as for cars. The Polk file does not include curb weights for light trucks. *Ward's Year Books* [32] provide curb weights for a detailed list of makes, models and subseries that translates readily to the light-truck-group [CG] and make-model [MM2] codes of this study. In each model year, *Ward's* supplies a curb weight for the "basic" vehicle in a particular CG and MM2. However, what engine and equipment is included in the "basic" vehicle (and what engines or equipment are "optional") depends on the manufacturer and can vary from year to year, resulting in fluctuations of the reported curb weights that may not reflect the trend in the average weight of vehicles as actually equipped and sold. A moderate number of the reported weights seem as much as several hundred pounds out of line with the pattern of previous or subsequent model years, or with the pattern of related vehicles (e.g., the same truck with 4-wheel drive). The weights were edited to establish smoother trends across model years and across closely related make-models (e.g., for a typical truck, the 4-wheel drive model should be consistently 400 pounds heavier than the rear-wheel drive model). The information was entered into a look-up table of curb weight by CG, MM2 and MY.

Wheelbase of light trucks is accurately specified in *Ward's Year Books* as well as other publications. So is the basic truck type [TRKTYP]. Where possible, light-truck groups have been defined so that all vehicles in the group have the same wheelbase. But when the VIN does not distinguish between short-bed and long-bed models, the principal variable WHLBASE is measured on the short-bed model, and the subsidiary variable WHLBASE2 (never used in the analyses of this report) is measured on the usually rarer long-bed model. Information about the drive train, air bags and ABS is derived from *Ward's* and from data in a NHTSA evaluation report [21].

Track widths of light trucks, unlike cars, are not routinely reported in handbooks or year books. The most extensive information on track widths may be found in a data base of measurements at NHTSA's Vehicle Research and Test Center [12]. Those data do not include some high-volume make-models, such as full-sized GM vans. NHTSA staff measured track widths on some of those make-models; information on a few others was obtained from NHTSA Research and Development's Vehicle Parameter Database (assembled from MVMA specification books). From one source or another, at least an estimate of track width was obtained for most light trucks. In general, track widths are the same for all vehicles in a light-truck group. Appendix E tabulates the curb weight, track width and wheelbase for 1985-93 light trucks.

2.3 EPA's weight measurements: trends and comparisons

The Environmental Protection Agency (EPA), as part of its compliance testing for CAFE standards, measures the actual weights of a representative set of **production** cars and light trucks. (The curb weight is generally 300 pounds less than the "EPA test weight.") These are "real" cars and trucks, in all likelihood equipped with options consumers usually want for that make-model (automatic transmission, air conditioning, radios, fancy decor, popular engines, etc.). Some test vehicles may be more "loaded" than usual and others more "stripped," but they average out to the typical vehicle. The data base of EPA test vehicles may not offer precise or complete information on each individual make-model, but it is excellent for estimating the average weight of all cars and light trucks on the road. Those estimates are useful for describing the trend in the actual weights of cars and light trucks during 1985-93. They are also useful for checking the accuracy of the estimates obtained, as described above, from the Polk and Ward's data.

During model years 1985-93, the sales-weighted average weights of new passenger cars and light trucks, based on EPA data, were as follows:

	Average Weight	
Model Year	Passenger Cars	Light Trucks
1985	2867	3560
1986	2821	3513
1987	2805	3497
1988	2831	3587
1989	2879	3658
1990	2906	3810
1991	2934	3716
1992	3007	3869
1993	2971	3901
1985-93 AVERAGE	**2891**	**3679**

The average light truck was about 800 pounds heavier than the average car. Between 1985 and 1993, the average car gained 100 pounds, but the average light truck, 340 pounds. Thus, the disparity between cars and trucks widened from under 700 to over 900 pounds. The truck weights in Appendix E show that much of the growth was **within** make-models, rather than due to a shift from light to heavy make-models. For example, the Dodge D-150 pickup truck (CG 7102, MM2 7104) grew from 3450 pounds in 1985 to 3732 pounds in 1993. Ford Ranger (CG 7401, MM2 7401) grew from 2600 pounds to 2820 pounds. Chevrolet 4x4 "S" Blazer (CG 7604, MM2 7610) increased from 3139 to 3512. Growth within make-models reflects trends toward heavier structure, more powerful engines, and additional luxury equipment.

The vehicle weights used in this study, based on Polk and *Ward's* data for cars and trucks without optional equipment, are likely to be lower than the EPA weights based on actual vehicles with typical optional equipment. The sales-weighted average weight for 1985-93 passenger cars on the NVPP file is 2833 pounds, which is 2 percent lower than the 2891 pounds on the EPA file. The discrepancy between Polk and EPA is small, because the Polk file does take into account the weight of optional engines and decor levels, and only excludes other optional equipment. The average weight for 1985-93 light trucks, based on *Ward's Almanacs* is 3476 pounds, which is 5.5 percent lower than the 3679 pounds on the EPA file; the discrepancy is larger because *Ward's* only specifies a single, baseline weight for each make-model. However, even for light trucks, the discrepancy is not excessive, and it has remained essentially constant from year to year. Since the goal of this report is to estimate the **relative** change in fatality risk for an **incremental** change in vehicle weight, as opposed to the absolute level of fatality risk associated with some specific weight, a generally consistent underreporting of weights on the order of 2 to 5.5 percent should not affect the results. Also, since the report does not address the relative safety of a car and light truck **of the same weight**, it does not matter that the car weights in this study are less underreported than the truck weights.

2.4 State data reduction

NHTSA has access to 11 State accident files that have data on the VINs of crash-involved vehicles during all or part of 1989-93:

Florida	1989-93	Illinois	1989-92
Louisiana	1990	Maryland	1989-92
Michigan	1989-91	Missouri	1989-93
New Mexico	1989-92	North Carolina	1992-93
Ohio	1991-93	Pennsylvania	1989-93
Utah	1989-93		

The VIN-analysis programs can be applied to these files to identify 1985-93 cars and light trucks and specify their curb weights and other characteristics. The task is to identify **induced-exposure crash involvements**: vehicles that had been standing still for some time, for a legitimate reason, and got hit by somebody else. The vehicle should have done nothing to precipitate or contribute to the collision. In this report, induced-exposure involvements are always in crashes involving two or more vehicles, and they defined in the 11 States are as follows:

Florida Vehicle maneuver must be "stopped" or "parked"; travel speed = 0; contributing factor must be "no improper driving"; vehicle fault code must be "not at fault"; violation must be "none."

Illinois Vehicle maneuver must be "stopped for traffic control" or "stopped for a turn" or "stopped in traffic" or "legally parked"; striking/struck cannot be "striking."

Louisiana Vehicle maneuver must be "stopped," "stopped, preparing to turn" or "parked"; travel speed must be 0; contributing factor must be "no violations" or "other or unknown violations"; object struck must be "none"; vehicle condition must be "no defect" or "other or unknown if defective."

Maryland Vehicle maneuver must be "stopped in traffic lane" or "parked"; contributing factor must be "none" or "unknown"; vehicle condition must be "no defects" or "unknown if defective."

Michigan Driver's intent must be "stopped on road"; hazardous action must be "none"; contributing circumstance must be "none."

Missouri Vehicle maneuver must be "stopped" or "parked"; contributing factor must be "no improper behavior."

New Mexico Last driver action must be "stopped" or "parked"; next-to-last driver action must be "does not apply"; contributing factors = "none"; first harmful event must be "collision of 2 vehicles."

N. Carolina Driver action must be "stopped" or "parked"; travel speed must be 0; contributing factor must be "none stated" or "parked"; citation, violation must be "none"; object struck must be "none" or "not stated"; vehicle condition must be "not defective," "not stated" or "unknown if defective."

Ohio Person [driver] action must be "stopped to turn," "stopped in traffic" or "parked"; travel speed must be "stopped"; contributing factor must be "no error" or "not stated"; citation must be "none"; object struck must be "nothing" or "not stated"; vehicle at fault in the crash (accident level) cannot be the number of this vehicle.

Pennsylvania Vehicle maneuver must be "stopped"; travel speed must be 0; if the prime cause is "driver" or "vehicle" then the prime-cause vehicle number cannot be the number of this vehicle.

Utah Vehicle maneuver must be "remain stopped" or "parked"; travel speed must be 0; contributing factor must be "did not contribute."

Also, the vehicle must be occupied by a person in the driver's seat, with known age and sex. This automatically excludes unoccupied, parked vehicles from the study. Four additional control variables are defined from the State data:

NITE equals 1 if the crash occurred between 7 P.M. and 7 A.M.; 0 otherwise. This variable is easy to define from all of the State files.

SURCOND equals 2 if the road surface was snowy or icy; 1 for "wet" or any other slippery condition; 0 otherwise. This variable is easy to define from all of the State files.

SPDLIM55 equals 1 if the speed limit was 55, 60 or 65; 0 otherwise. In Illinois or New Mexico, as a surrogate, equals 1 if the road was rural and/or interstate. In Michigan, there is no good surrogate, and all crashes have this variable set to 0.

RURAL equals 1 if the accident location was rural; 0 otherwise. Only Florida, North Carolina, Ohio and Pennsylvania have a separate "rural/urban" variable. In Illinois and New Mexico, the roadway class variable indicates rural/urban. In Maryland, the locality variable. In Missouri, the population group variable. In Louisiana, set RURAL = 1 if population group is "rural or unincorporated" **and** locality is "open country, residential scattered or unknown." In Utah, set RURAL = 1 if road class is "rural non-State highway" **or** locality is "farms, fields, open country." In Michigan, there is no good surrogate, and all crashes have this variable set to 0.

The sample sizes of induced-exposure crashes vary considerably from State to State, and are as follows:

	Passenger Cars	Light Trucks
Florida	108,122	35,209
Illinois	131,385	36,495
Louisiana	7,113	4,117
Maryland	21,700	6,089
Michigan	78,954	30,254
Missouri	37,427	14,789
New Mexico	7,467	5,373
North Carolina	20,761	7,533
Ohio	83,187	27,779
Pennsylvania	56,825	17,262
Utah	6,930	3,729
TOTAL	**559,871**	**188,629**

Samples vary between States due to circumstances such as number of registered vehicles in the State, number of years of data in this study (e.g., one for Louisiana, five for Florida), accident reporting thresholds and traffic density (higher in the urbanized States, resulting in more multivehicle crashes). The overall samples of 559,871 cars and 188,629 light trucks are more than ample for the proposed statistical analyses.

2.5 FARS data reduction

The reduction of fatal accident data requires not only identifying and classifying 1985-93 cars and light trucks, but also classifying the type of fatal crash they were involved in. Fatal accident cases are extracted from FARS, rather than directly from the State files, to allow a consistent coding scheme for the type of crash. One part of the FARS data reduction - vehicle classification and specifications - is performed exactly as in the preceding section, and is limited to data from 11 States, each State for the range of calendar years listed above. The methods of the preceding section furnish a list of 1985-93 cars and light trucks in fatal crashes, specifying the curb weight and other characteristics of the vehicles, the age and sex of the drivers, and the subsidiary control variables NITE, SURCOND, SPDLIM55 and RURAL (which are defined directly from the FARS data, but are set to zero in all Michigan cases, since the Michigan induced-exposure cases also had them set to zero).

To classify the type of fatal crash, however, it is necessary to know the harmful events, impact areas and precrash maneuvers of **every** vehicle in the crash: not only the 1985-93 car or light truck (the "case" vehicle), but also the "other" vehicle in a two-vehicle crash. It is necessary to know the basic body type of the "other" vehicle: passenger car, light truck, heavy truck/bus (GVW > 10,000 pounds), motorcycle or unknown. The VIN is the most reliable information for defining the body type. As shown in Appendix A, the first three or four letters of the VIN are used to distinguish the basic body type of all **1981**-93 vehicle records with valid VINs. For pre-1981 vehicles, or for vehicle records with missing or nonvalid VINs, the BODY_TYP variable on FARS is used instead. Thus, the first step of the FARS data reduction creates two files: a listing of 1985-93 cars and light trucks, including all variables in the State data analysis, plus the harmful events, impact areas and precrash maneuver; **and** a listing of **every** vehicle involved in a two-vehicle crash in the 11 States, during the applicable calendar years, indicating the basic body type, precrash maneuver and impact area.

Fatal crashes are classified using the rather detailed two-digit code described in the two pages of Table 2-1. Crashes involving three or more vehicles, or multiple vehicles and a pedestrian(s), or where there is no information about the "other" vehicle will not be analyzed in this report, and are assigned codes 91-99. Crashes involving a single 1985-93 car or light truck, and no other vehicles except, perhaps, an unoccupied parked vehicle(s), are grouped into codes 11-17, 21 and 81, based on the FARS variables HARM_EV (1st harmful event), M_HARM (most harmful event), IMPACT2 (principal damage location) and ROLLOVER. Principal, noncollision rollovers are coded 11; collisions with pedestrians, bicyclists and other nonmotorists, 21; and collisions with parked cars, 81. All other single vehicle crashes (with or without subsequent rollover) are coded 12-17; most of those crashes are collisions with fixed objects, but some are collisions with trains or animals, immersions and fires, and complex off-road excursions.

For two-vehicle crashes, the "case" vehicle, which is always a 1985-93 car or light truck with a valid VIN and known driver age and sex, is matched up with the "other" vehicle in the FARS accident case, which may or may not be a 1985-93 car or light truck. If the "other" vehicle is a motorcycle or all terrain vehicle, the fatal crash type is coded 22. If it is a heavy truck or bus, the crash type is coded 31-39, depending on the damage location on the case vehicle.

If the "other" vehicle is a passenger car (possibly, but not necessarily 1985-93), the crash type is coded 41-59, depending on the precrash maneuver (VEH_MAN) and impact locations (IMPACT1) of each vehicle. The intention of defining so many different codes is not to perform a separate analysis of each, but to allow flexibility for grouping the individual codes into larger classes. The only crashes that are really common are 41 (true head-on), 47 (front straight ahead into side), 51 (left to front) and 53 (right to front). If the "other" vehicle is a light truck, the crash type is coded 61-79, using the same scheme as above, but adding 20 to each code.

For crash types 41-79, the variables retained in each record depends on the status of the "other" vehicle. If the "other" vehicle is not a 1985-93 car or light truck, or if it has an unknown or nonvalid VIN, or if its driver's age or sex are unknown, all information about the "other" vehicle is dropped from the file after the crash type is coded. The record looks a lot like a single-vehicle crash, with information on the "case" vehicle only. But if the "other" vehicle is a 1985-93 car or light truck with complete specifications and driver information, this material is retained in the record, to allow the use of this record in analyses of fatality risk as a function of the weights and

TABLE 2-1

CODES AND DEFINITIONS OF FATAL CRASH TYPES

11-17: SINGLE-VEHICLE NONPEDESTRIAN CRASHES

11	principal (noncollision) rollover - includes: first-harmful-event rollovers (HARM_EV = 1); first harmful event is contact with curb or ditch (HARM_EV = 33,34) and most harmful event is rollover (M_HARM = 1); first and most harmful event is curb or ditch, rollover occurred, principal damage is on top of vehicle (IMPACT2 = 13); first harmful event is "other noncollision" (HARM_EV = 7) and most harmful event is rollover
12	collision-induced rollover (most-harmful-event, single-vehicle) - includes: first harmful event is collision with an animal, or a parked car, or any object other than a curb or ditch (HARM_EV = 11,14,17-32,35-46) and most harmful event is rollover
13	frontal impact (IMPACT2 = 11,12,1) with fixed object (M_HARM = 17-46), excluding crash types 11,12 above
14	side impact (IMPACT2 = 2-4,8-10) with fixed object excluding crash types 11,12 above
15	other or unknown impact with fixed object excluding crash types 11,12 above
16	collision with train or animal (M_HARM = 10,11) excluding crash types 11,12 above
17	all other non-pedestrian single-vehicle crashes (all single-vehicle crashes not included in types 11-16, 21 or 81)

21-22: COLLISIONS WITH SMALL ROAD USERS (PEDESTRIANS, BICYCLISTS, MOTORCYCLISTS)

21	single-vehicle collision with pedestrian, bicyclist, or other nonmotorist (HARM_EV = 8,9,15)
22	2-vehicle nonpedestrian collisions: the other vehicle is a motorcycle

31-39: 2-VEHICLE NONPEDESTRIAN COLLISIONS: THE "OTHER" VEHICLE IS A BIG TRUCK OR BUS (GVW > 10,000 POUNDS)

31	impact with big truck: frontal damage to case vehicle (IMPACT2 = 11,12,1)
32	impact by big truck: side damage to case vehicle (IMPACT2 = 2-4,8-10)
33	impact by big truck: rear damage to case vehicle (IMPACT2 = 5-7)
39	impact with big truck: other or unknown damage to case vehicle

TABLE 2-1 (Continued)

CODES AND DEFINITIONS OF FATAL CRASH TYPES

41-59: 2-VEHICLE NONPEDESTRIAN COLLISIONS: THE "OTHER" VEHICLE IS A PASSENGER CAR

41	true head-on collision: each vehicle going straight ahead (VEH_MAN = 1,5,9,16,17; includes passing, changing lanes, going around a curve), both vehicles impacting frontally (IMPACT1 = 11,12,1)
42	front-to-front impact, case vehicle going straight ahead, other vehicle turning (VEH_MAN = 2-3,6-8,10-15,98-99; includes all slow or unknown maneuvers)
43	front-to-front impact, case vehicle straight, other vehicle stopped (VEH_MAN = 4,7)
44	front-to-front impact, case vehicle turning, other vehicle straight
45	front-to-front impact, case vehicle stopped, other vehicle straight
46	front-to-front impact, both vehicles turning, stopped or unknown maneuver
47	case vehicle front hits other vehicle's side (IMPACT1 = 2-4,8-10), case vehicle going straight ahead
48	case vehicle front hits other vehicle's side, case vehicle turning, stopped or unknown maneuver
49	case vehicle front hits other vehicle's rear (IMPACT1 = 5-7)
51	case vehicle left side (IMPACT1 = 8-10) hit by other vehicle's front
52	case vehicle left side, other vehicle nonfrontal or unknown impact
53	case vehicle right side (IMPACT1 = 2-4) hit by other vehicle's front
54	case vehicle right side, other vehicle nonfrontal or unknown impact
55	case vehicle's rear hit by other vehicle's front
56	case vehicle's rear hit by other or unknown part of the other vehicle
57	case vehicle other/unknown part hits other vehicle's side
58	case vehicle other/unknown part hits other vehicle's rear
59	all other 2-veh crashes, including those without any damage information

61-79: 2-VEHICLE NONPEDESTRIAN COLLISIONS: THE "OTHER" VEHICLE IS A LIGHT TRUCK

61-79	same coding scheme as 41-59; just add 20 when the "other" vehicle is a light truck rather than a passenger car

81: ONE MOVING VEHICLE HITS PARKED VEHICLE(S)

81	collision with unoccupied parked vehicle(s) (M_HARM = 14)

TABLE 2-1 (Continued)

CODES AND DEFINITIONS OF FATAL CRASH TYPES

91-99: ALL OTHER CRASHES

91	crash involving 3 or more vehicles (no pedestrians)
98	crash involving 2 or more vehicles, plus pedestrian(s)
99	2-vehicle crash, "other" vehicle is unknown type

other characteristics of **both** vehicles in the crash.

A final, crucial variable describes the outcome of the crash: the number of fatalities. The FARS variable FATALS, the **total** number of people killed in the crash, **including** occupants of the "case" vehicle, occupants of other vehicles, and nonoccupants, will be used throughout the analyses of this report, consistent with the objectives described in Section 1.1 and the approach of Mengert and Borener reviewed in Section 1.5. The FARS variables DEATHS (fatalities in the case vehicle only) and INJ_SEV (outcome for the driver of the case vehicle) were also retained.

The product of the FARS data reduction is four accident files:

(1) The "case" vehicle is a 1985-93 **passenger car**; the crash type is 41-79; the "other" vehicle is a 1985-93 passenger car or light truck with valid VIN and known driver age and sex; each record contains information on both vehicles and their drivers, plus accident-level information (STATE, NITE, FATALS, etc.): 4,617 records.

(2) The "case" vehicle is a 1985-93 **passenger car**; the crash type is 11-99; if the crash type is 41-79, the "other" vehicle is not model year 1985-93, or does not have a valid VIN, or its driver's age or sex is unknown; each record contains information on the case vehicle and its driver only, plus accident-level information: 17,035 records.

(3) The "case" vehicle is a 1985-93 **light truck**; the crash type is 41-79; the "other" vehicle is a 1985-93 passenger car or light truck with valid VIN and known driver age and sex; each record contains information on both vehicles and their drivers, plus accident-level information: 2,113 records.

(4) The "case" vehicle is a 1985-93 **light truck**; the crash type is 11-99; if the crash type is 41-79, the "other" vehicle is not model year 1985-93, or does not have a valid VIN, or its driver's age or sex is unknown; each record contains information on the case vehicle and its driver only, plus accident-level information: 7,996 records.

In all, there are 21,652 passenger-car and 10,109 light-truck "case" vehicle records available for the analyses. Note that a FARS collision between two 1985-93 passenger cars with valid VINs will appear twice on file (1): once with Vehicle No. 1 as the "case" vehicle and Vehicle No. 2 as the "other" vehicle, and a second time with Vehicle No. 2 as the case vehicle and Vehicle No. 1 as the other vehicle. The accident-level information will be the same in both cases. Similarly a collision between a 1985-93 passenger car and a 1985-93 light truck, each with valid VINs, will appear once on file (1) with the car as the case vehicle and "crash type" in the 61-79 range, and once on file (3) with the light truck as the case vehicle and "crash type" in the 41-59 range.

2.6 Unadjusted fatality rates per 1000 induced-exposure crashes

The FARS and State files are combined to form a single data base consisting of fatal involvements and induced-exposure involvements. Before any regression analyses, it is appropriate to inspect the basic patterns in the data. The cases are grouped by vehicle weight, and the simple, unadjusted fatality rate (ratio of fatal to induced-exposure involvements) is calculated and graphed for each class interval of vehicle weight.

Figure 2-1 graphs the overall fatality rate (any type of fatal involvement) for **passenger cars** by vehicle weight. Cars were grouped into 100-pound weight intervals (or 300 pound intervals at the upper and lower ends, where the data are sparser), with centroids ranging from 1800 to 4100 pounds. The vertical axis is the logarithm of the fatality rate. Figure 2-1, frankly, does not show a trend of reduced fatalities as weight increases. The "crossed-swords" pattern in the data is certainly peculiar, and it reveals what happens when the data are not adjusted for driver age and sex. The cars in the 3000-3300 pound range, which have some of the highest fatality rates, are to a large extent Ford Mustang, pre-1989 Ford Thunderbird and Mercury Cougar, Chevrolet Camaro and Monte Carlo, and Pontiac Firebird: vehicles that are well-known for attracting young males and other aggressive drivers. The cars in the 2500-2600 pound range with very low fatality rates include the earlier Honda Accord, Aries and Reliant, Tempo and Topaz, Mazda 626 and Subaru wagon: vehicles with a reputation for "responsible" drivers, and a high level of urban, daytime use. These factors are strong enough to mask any vehicle-weight trend.

Figure 2-2 limits the fatal accident data to **principal rollovers** and presents the ratio of rollover fatalities to induced exposure. Previous studies have shown a strong negative correlation between vehicle size and rollover risk, and Figure 2-2 certainly confirms that trend. Alas, the 80 percent reduction in rollovers for the largest cars relative to the smallest cars, as shown in Figure 2-2, is **too** strong. The smallest cars are popular with younger drivers, who tend to driving behaviors that lead to rollovers. After control for driver age and sex, it is likely that the effect of vehicle weight will be not be as strong.

Figure 2-3 considers collisions between **two passenger cars**. Fatality risk is tabulated by the weight of the "case" vehicle. The "other" vehicle is a passenger car of unspecified weight. The stars represent the risk of an occupant fatality in the "case" vehicle. As might be expected, occupant fatality risk decreases steadily as weight increases. But as the "case" vehicles get heavier, they increase the fatality risk to occupants of the "other" vehicle, as evidenced by the trend in the circles. Thus, the principal measure of fatality risk in this report - the total number of fatalities in the crash (case plus other vehicle occupants), depicted by the solid bullets, remains virtually constant as the case vehicle's weight increases.

Figures 2-4 - 2-6 depict comparable trends for **light trucks**. Figure 2-4 graphs the overall fatal involvement rate relative to induced exposure. It shows a rather unambiguous trend of **increasing** fatality rates as trucks get heavier. Here is the first warning that the induced-exposure approach of this chapter is not suitable with light trucks. As explained in Section 1.4, induced exposure is not a "pure," unbiased surrogate for exposure, and it could even be confounded with vehicle weight. The upward trend in Figure 2-4 could indicate biases in the induced-exposure method (induced-exposure crashes of larger trucks are underreported, resulting in spurious high fatality rates), or it could reflect genuine safety problems with larger trucks, or confounding effects of driver age and sex, etc., or some combination of these.

Figure 2-5 presents the rollover fatality rate for light trucks. Unlike passenger cars (Figure 2-2), there is no downward trend as weight increases. Since the connection between mass and the static rollover stability factor is weaker in light trucks than in cars (see Section 1.2), it is not

FIGURE 2-1

PASSENGER CARS
OVERALL FATAL ACCIDENT RATE PER 1000 INDUCED-EXPOSURE CRASHES
BY CAR WEIGHT

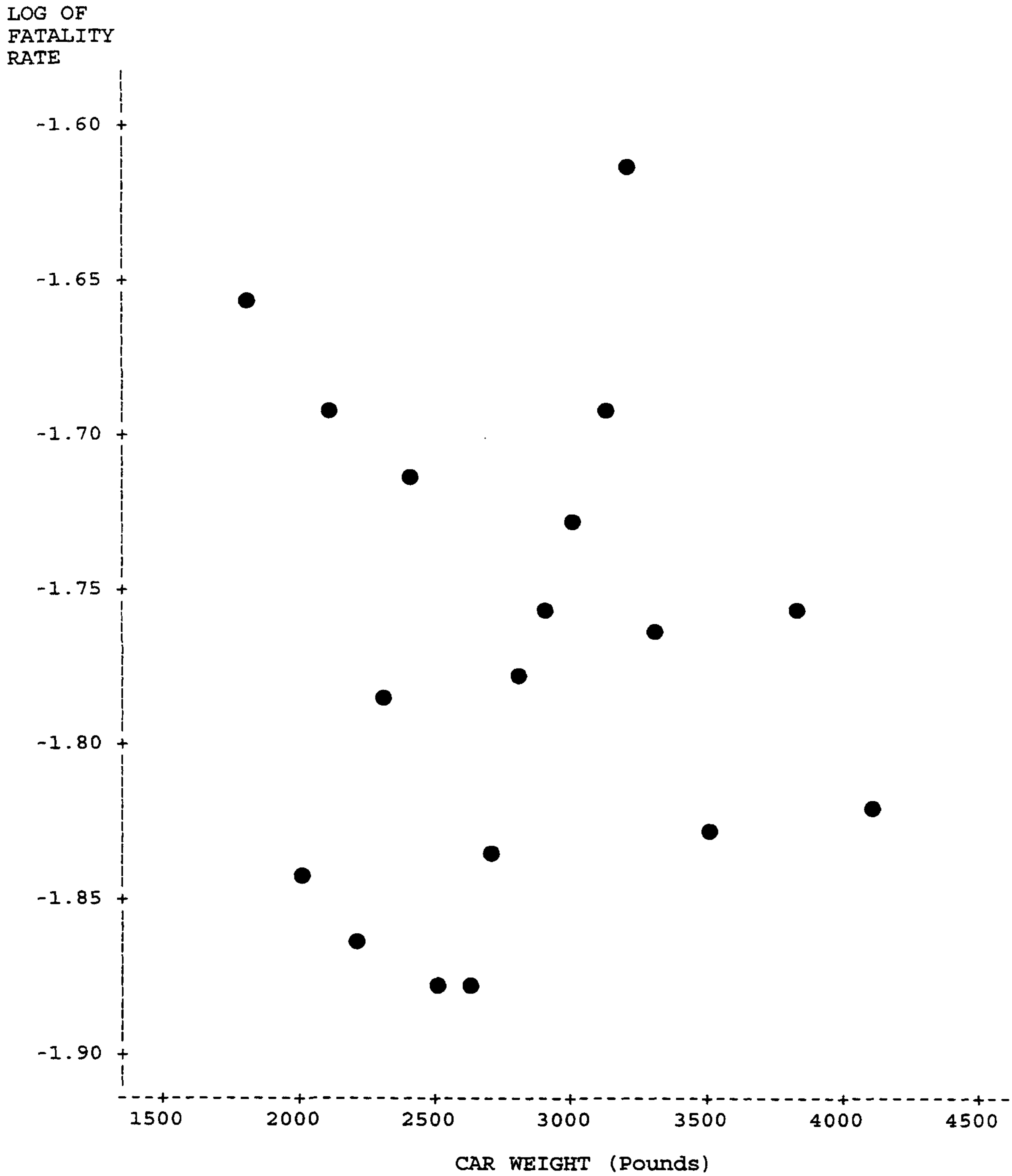


FIGURE 2-2

PASSENGER CARS
ROLLOVER FATALITY RATE PER 1000 INDUCED-EXPOSURE CRASHES
BY CAR WEIGHT

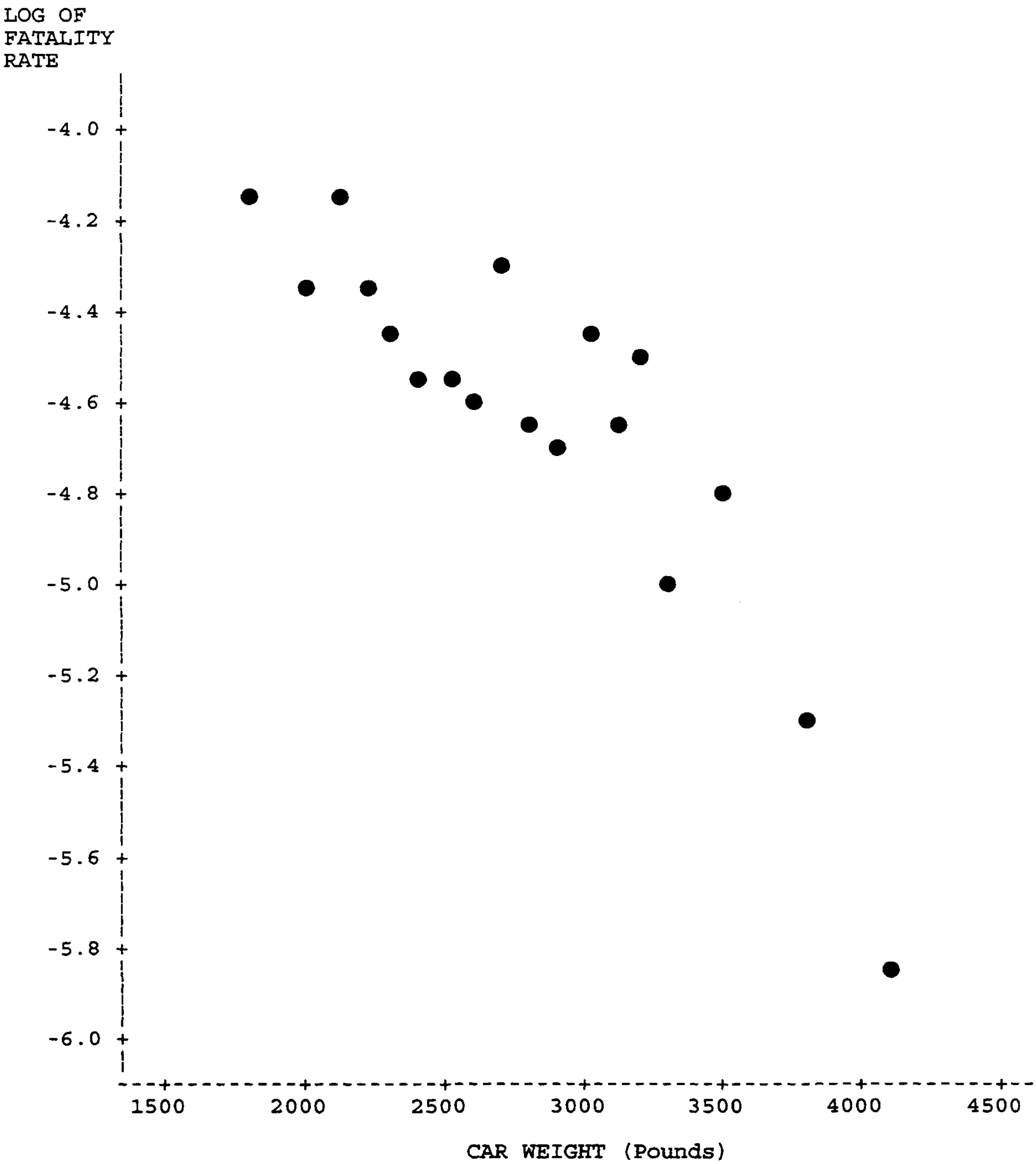


FIGURE 2-3

PASSENGER CARS
FATALITY RATE IN **CAR-TO-CAR** COLLISIONS, PER 1000 INDUCED-EXPOSURE CRASHES
BY WEIGHT OF THE "CASE" CAR

('●' = fatalities in the crash
'★' = case vehicle occupant fatalities
'O' = other vehicle occupant fatalities)

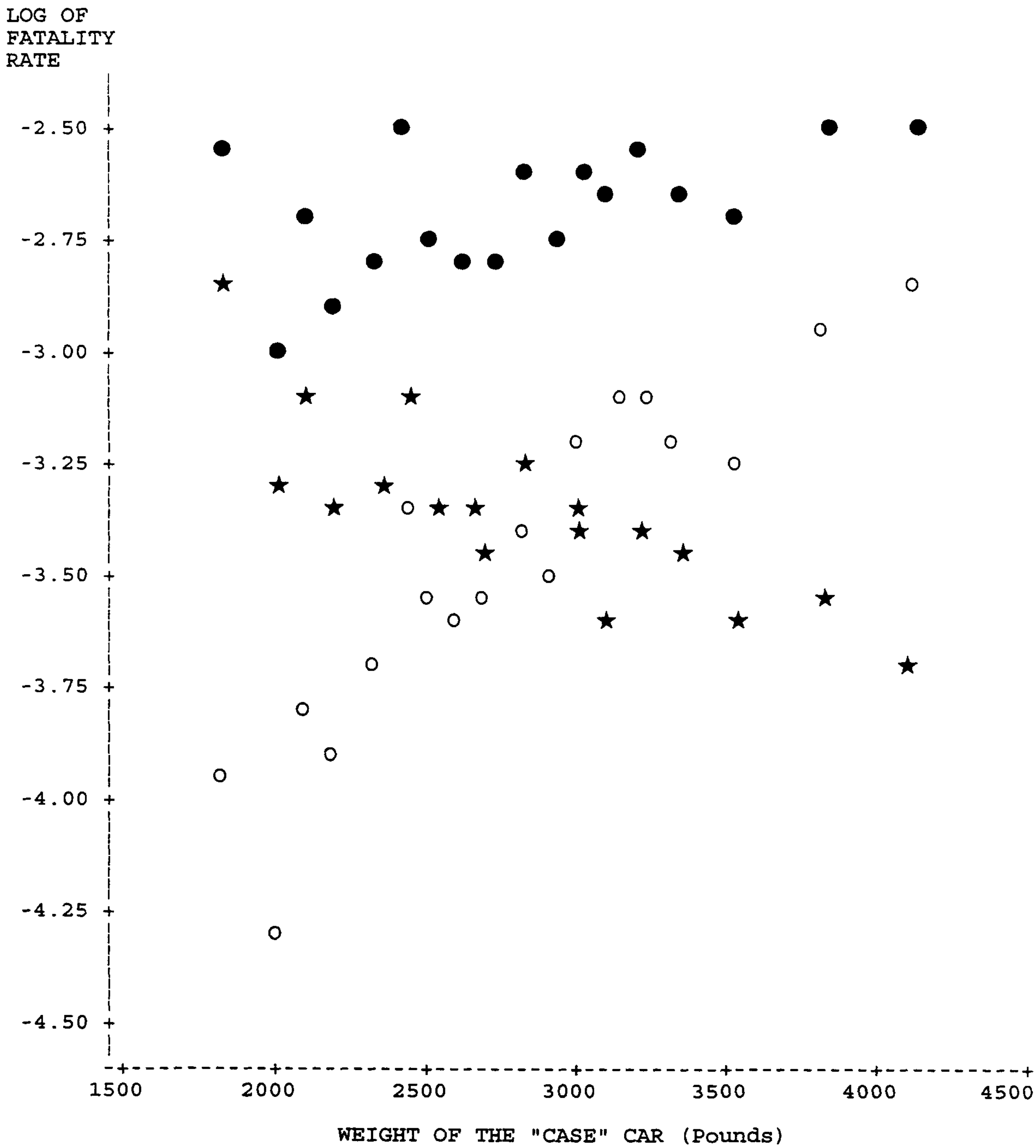


FIGURE 2-4

LIGHT TRUCKS
OVERALL FATAL ACCIDENT RATE PER 1000 INDUCED-EXPOSURE CRASHES
BY LIGHT TRUCK WEIGHT

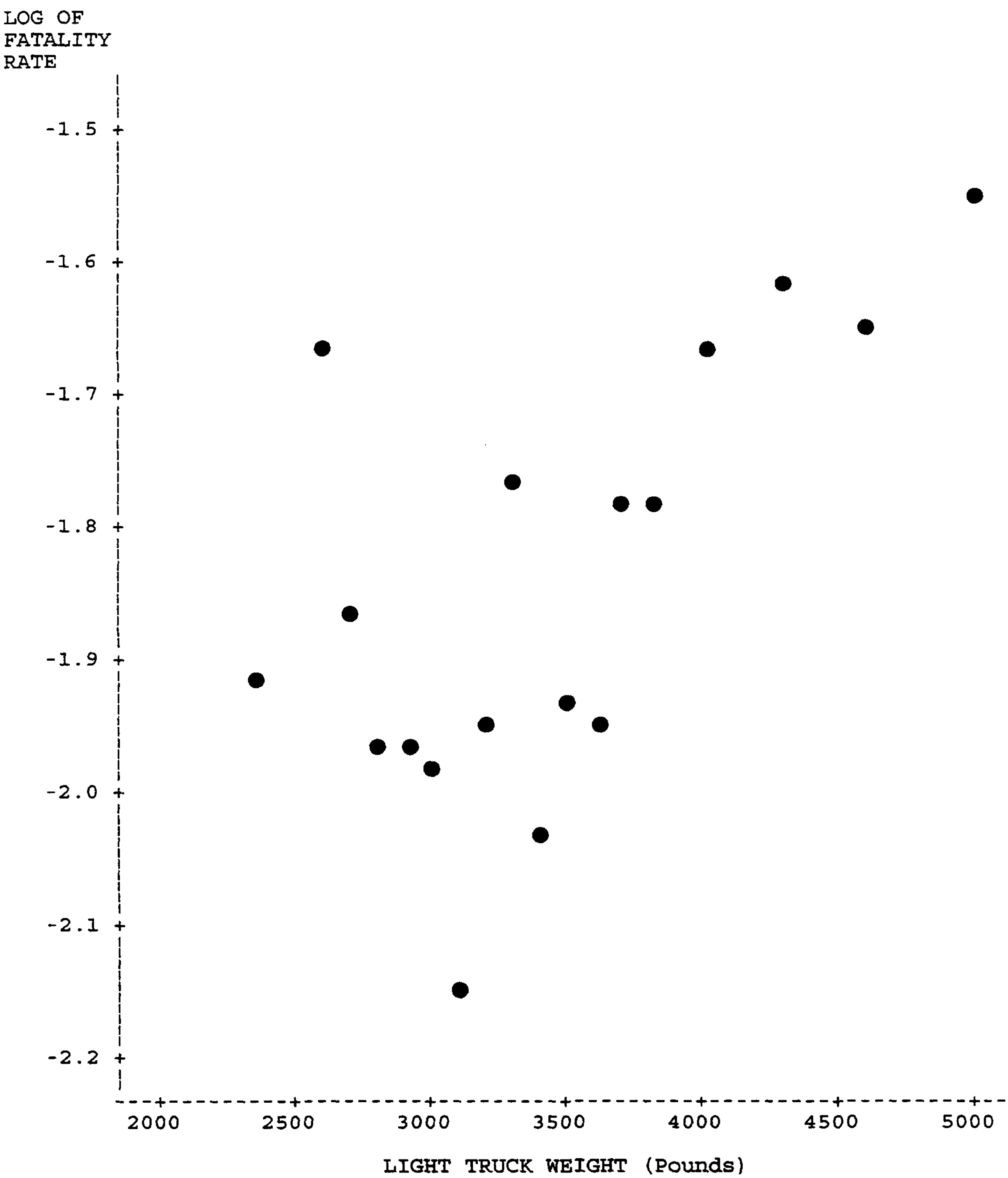


FIGURE 2-5

LIGHT TRUCKS
ROLLOVER FATALITY RATE PER 1000 INDUCED-EXPOSURE CRASHES
BY LIGHT TRUCK WEIGHT

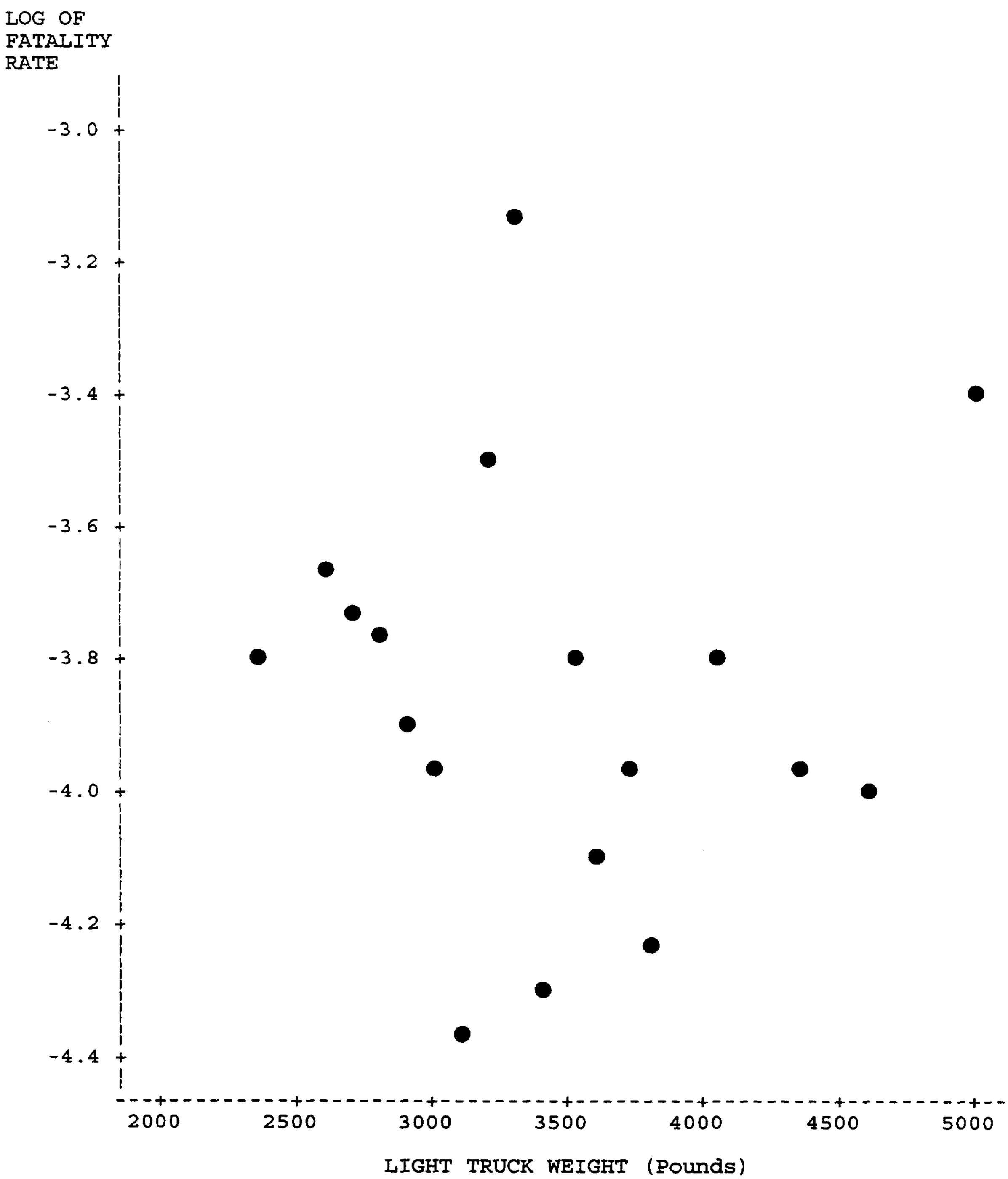
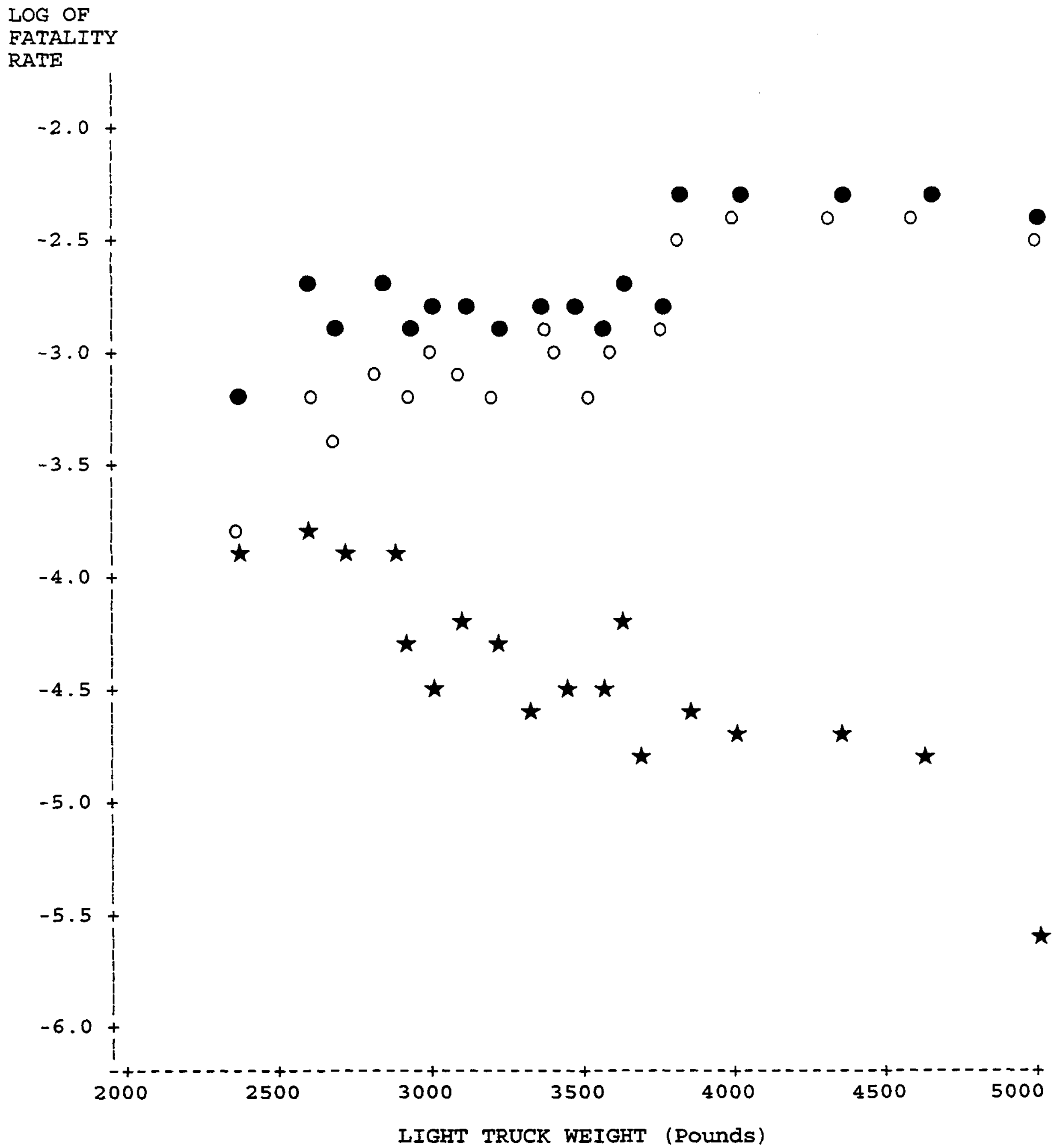


FIGURE 2-6

LIGHT TRUCKS
FATALITY RATE IN **LIGHT TRUCK-TO-CAR** COLLISIONS
PER 1000 INDUCED-EXPOSURE CRASHES
BY WEIGHT OF THE LIGHT TRUCK

('●' = fatalities in the crash
'★' = light truck occupant fatalities
'O' = passenger car occupant fatalities)



surprising to find less association between mass and fatality risk. Also, biases in the induced-exposure method may be masking any benefits for increased weight.

Figure 2-6 shows fatality rates when a **light truck collides with a passenger car**, depending on the weight of the truck (the weight of the car is unspecified). The stars show the fatality rate for occupants of the trucks; appropriately, it decreases as the weight of the truck increases. The circles show the trend in fatality rates for the car occupants in these crashes. The heavier the trucks, the more fatalities in the cars. The solid bullets indicate the overall fatality rate in the crash. Figure 2-6 differs from Figure 2-3 in some important respects. The average light truck is 800 pounds heavier than the average car. Except for the very smallest light trucks, the overwhelming majority of fatalities in car-truck collisions are the occupants of the cars. Thus, the circles (car occupant fatalities) and bullets (overall fatalities) are at almost the same level for all except the smallest light trucks. Since the car occupant fatality rate increases as truck weight increases (the circles), so does the overall fatality rate (the bullets).

CHAPTER 3

FATALITIES PER 1000 INDUCED-EXPOSURE CRASHES IN 11 STATES: RESULTS

3.1 Logistic regression: setting up the variables

The combined FARS and State data base defined in the previous chapter can be used, with relatively simple transformations of certain variables, to drive logistic regression analyses of fatality risk per 1000 induced-exposure crashes, by curb weight (or track width, or wheelbase) and a list of control variables including driver age and sex. The procedure is best illustrated by an example: principal rollovers of passenger cars, by curb weight. It includes setting up the variables, revising the induced-exposure data base and running the regression.

Logistic regression on disaggregate data, using maximum likelihood principles, is performed by the LOGIST procedure on the Statistical Analysis System (SAS) [15]. The dependent variable, ROLLFAT, has value 0 or 1, also called "success" or "failure." In this case, a "success" is an involvement in an induced-exposure crash: a surrogate for a car experiencing a unit of exposure without a fatality. Each fatality in a principal rollover counts as a "failure." Thus, if a FARS record is a principal rollover (CRASHTYP = 11) resulting in one fatality (FATALS = 1), one data point with ROLLFAT set to 1 is generated from the FARS record; if there were two fatalities (FATALS = 2), two identical data points with ROLLFAT set to 1 are generated from the FARS record, etc. FARS cases that are not principal rollovers are not used in this regression. Every induced-exposure case from the State files generates one data point with ROLLFAT set to 0 (success).

Logistic regression uses a large number of **individual** observations of success or failure, comprising a wide variety of actual combinations of the independent variables, to predict the **probability of failure** under any hypothetical combination of the independent variables. Specifically, the model generates an equation which expresses the log-odds of a failure as a linear function of the independent variables:

$$\log (\text{fatals/induced exposure}) = A_0 + A_1 * \text{CURBWT} + A_2 * V_2 + \ldots$$

The principal independent variable, in this case, is the curb weight (CURBWT), which is entered directly, without any transformations. Thus, the regression coefficient will indicate the change in the log-odds of a fatality, given a one-pound increase in curb weight. For example, a coefficient of - .0002 indicates that a 100-pound increase in curb weight is associated with a 2 percent fatality reduction per 1000 induced-exposure crashes:

$$\log (F_W/IE_W) = A_0 + -.0002 * W + A_2 * V_2 + \ldots$$
$$\log (F_{W+100}/IE_{W+100}) = A_0 + -.0002 * (W+100) + A_2 * V_2 + \ldots$$
$$\log (F_{W+100}/IE_{W+100}) - \log (F_W/IE_W) = -.02$$
$$(F_{W+100}/IE_{W+100}) / (F_W/IE_W) = \exp(-.02) = .98$$

The most important control variables are the driver's age and sex. As discussed in Section 1.3, the driver-age effect is not linear, and it is different for males and females. The age effects for males and females in the actual data in Figure 1-1 came reasonably close to "asymmetric V's with flat bases." The risk for males was flat between ages 35 and 50. Below age 35, it increased almost linearly as the drivers got younger. Above age 50, the risk also increased, but not as strongly. The risk for female drivers paralleled the risk for males, at a substantially lower level, up to age 45. Afterwards, it climbs quickly and catches up with the risk for males. The right part of the "V" for females has a steeper slope than for males, and it starts sooner (45 rather than 50). The data suggest that the effect can be modeled by piecewise linear functions:

FEMALE = 1 for females, 0 for males
YOUNGDRV = 35-AGE for drivers under 35, 0 for all others
OLDMAN = AGE-50 for males over 50, 0 for all others
OLDWOMAN = AGE-45 for females over 45, 0 for all others

Whereas other formulations of the age and sex variables - e.g., quadratic and interaction terms AGE^2 and AGE^2*SEX - could have been used, the preceding ones were chosen because of their simplicity, ease of interpretation, and high likelihood of accurate calibration during regression analyses (a potential problem with quadratic terms).

The fatality rate per 1000 induced-exposure crashes varies greatly from State to State, due to different accident reporting thresholds and levels of traffic density. With 11 States in the analysis, it is appropriate to define 10 variables, ILLINOIS, LOUISIAN, etc., set to 1 if the crash occurred in that State and 0 otherwise; Florida crashes get the value of 0 for all 10 variables. Convertibles and two-door cars have higher fatality rates than four-door cars and station wagons. The body-type variable is used to define three dichotomous variables CONVRTBL, TWODOOR and STAWAGON. All three are set to zero if the case vehicle is a four-door car. Fatality risk varied from year to year during 1989-93. The calendar year of the crash is used to define four dichotomous variables CY89, CY90, CY92 and CY93. All are set to zero for 1991 crashes.

Antilock brake systems were associated with an increase in passenger car rollovers [20]. The control variable ABS4 was defined to be 1 for cars with standard, 4-wheel ABS, 0 for cars without 4-wheel ABS (that includes a few cars with rear-wheel ABS), and .5 for a small number of make-models that had approximately 50 percent optional ABS installation. Since air bags have little effect in rollovers [19], no AIRBAG variable is used in this regression; however, in analyses that involve frontal crashes, AIRBAG is set to 1 for cars with driver or dual air bags, 0 otherwise. Two dichotomous control variables are defined from the drive train: AWD and FWD (both are set to zero for rear-wheel-drive cars).

The accident-scene descriptors NITE, SPDLIM55 and RURAL defined in Section 2.4 are already dichotomous and may be used directly in the regressions. The surface condition is used to define two dichotomous variables WET and SNOW_ICE (both set to zero on dry roads). Finally, vehicle age has been observed to have a log-linear relationship with fatality rates (positive or negative, depending on the type of crash and the unit of exposure), once the car is more than a year old; fatality rates are higher than the linear trend for vehicles less than a year old [8], pp. 39-41. Two control variables are defined: VEHAGE, set to the actual vehicle age (CY - MY), but set to zero if this is negative; and BRANDNEW, set to 1 if CY $\leq$ MY, 0 otherwise.

Initial regression analyses also included an independent variable, POWER, which was the ratio of the engine displacement (CUBES) to CURBWT. The rationale was that cars with big engines (relative to their weight) attract aggressive drivers. POWER turned out to have a strong correlation with CURBWT ($r = .766$), since engine size generally grows faster than curb weight. When two independent variables are excessively intercorrelated, regression analyses can produce meaningless coefficients. Sometimes, the problem is quickly recognized because one of the regression coefficients will have the "wrong sign" (a counterintuitive relationship with the dependent variable). At other times, the flaw is more insidious. Both regression coefficients can have the "right sign," but their **magnitudes** are quite exaggerated because the regression is "playing off one variable against the other." Analysts are easily fooled if they simply don't know what the magnitudes "ought to be" or, worse, if they erroneously believe the effect will be strong ("I just know xxxx saves lives"). In this case, the initial regressions showed strong, but not obviously unreasonable effects in the right directions for curb weight (more weight = lower risk) and POWER (more POWER = higher risk). The magnitudes of the effects were surprising, but suspicions were not fully confirmed until the regression for pedestrian crashes (where the expected effect for more curb weight is higher, or unchanged risk) also showed a strong fatality reduction with increasing car weight. Problems like these make regression analysis a challenge and an inexact science. It should be avoided when simpler techniques can do the job. The analytic objectives of this report, however, can only be achieved with regression analyses.

The control variable RURAL was also dropped after initial analyses, because it is somewhat redundant with SPDLIM55, and because it could only be defined using surrogate variables in some of the State files, leading to possible inconsistencies with FARS and between States.

3.2 Revision of the induced-exposure data bases

The full induced-exposure file of 559,871 vehicle records was too large for regression analyses, given available facilities. Also, it contains inordinate numbers of cases from States with low accident-reporting thresholds (Illinois, Michigan and Ohio) and it could give a weight to data from those States that is out of line with their share of the fatalities. The file was reduced to a target size of 100,000 cases (actual yield: 100,114) by performing simple random sampling within each State. The sampling fraction in each State was selected to obtain the same ratio of fatal involvements per 1000 induced-exposure involvements in each State. Whereas the fatality rate per 1000 induced-exposure involvements varied in the original file from 20.1 in Illinois (low reporting threshold) to 64.9 in Pennsylvania (high reporting threshold), the rate on the new file is 216 in each State. Similarly, the original induced-exposure file of 188,629 light trucks was reduced to a target size of 50,000 cases (actual yield: 50,037):

	Original Induced Exposure	Fatal Crashes	Fat. Rate/ 1000	Revised Sampling Fraction	Revised Induced Exposure
	Passenger Cars: Creation of 100,000 Case Induced-Exposure File				
Florida	108,122	5,836	54.0	.2493	26,931
Illinois	131,385	2,638	20.1	.0927	12,202
Louisiana	7,113	281	39.5	.1825	1,255
Maryland	21,700	1,382	63.7	.2941	6,305
Michigan	78,954	1,964	24.9	.1149	8,987
Missouri	37,427	1,873	50.0	.2311	8,654
New Mexico	7,467	412	55.2	.2548	1,850
North Carolina	20,761	1,211	58.3	.2694	5,695
Ohio	83,187	1,919	23.1	.1065	8,935
Pennsylvania	56,825	3,688	64.9	.2997	17,207
Utah	6,930	448	64.6	.2985	2,093
TOTAL	**559,871**	**21,652**			**100,114**
	Light Trucks: Creation of 50,000 Case Induced-Exposure File				
Florida	35,209	2,712	77.0	.3809	13,374
Illinois	36,495	949	26.0	.1286	4,733
Louisiana	4,117	201	48.8	.2414	1,040
Maryland	6,089	580	95.3	.4711	2,848
Michigan	30,254	961	31.8	.1571	4,759
Missouri	14,789	1,020	69.0	.3411	5,009
New Mexico	5,373	488	90.8	.4492	2,461
North Carolina	7,533	575	76.3	.3775	2,847
Ohio	27,779	811	29.2	.1444	4,032
Pennsylvania	17,262	1,472	85.3	.4217	7,331
Utah	3,729	340	91.2	.4509	1,603
TOTAL	**188,629**	**10,109**			**50,037**

Unlike the situation with passenger cars, the original induced-exposure file of 188,629 cases, although cumbersome, was still usable in regression analyses. Direct comparisons of the original and revised files were achieved by performing regressions for principal rollovers and fixed-object collisions, each one with the original and the revised file. In both cases, there was less than a 10 percent difference between the original and revised files in the regression coefficients for the key independent variable CURBWT (a fraction of one standard deviation for those coefficients). Coefficients for control variables that have high interaction with fatality risk, such as driver age, NITE, SPDLIM55 and WET, were identical in the first two significant digits (less than 1 percent discrepancy). Chi-square values for curb weight and significant control variables were similar for both regressions. (Of course, the coefficients for the intercept and the 10 State variables were quite different, as expected.)

3.3 An example: logistic regression of passenger car rollovers

The data are now ready for the analysis of passenger car rollover fatalities by curb weight, as documented in Table 3-1. There were 971 actual principal-rollover fatal crashes involving passenger cars. They resulted in 1036 occupant fatalities (1.07 fatalities per crash). So there are 1036 data points with the dependent variable, ROLLFAT = 1. As stated above, there are 100,114 records on the revised induced-exposure file. After deletion of the very small number of cases with unknown curb weight, there are 100,028 data points with the dependent variable ROLLFAT = 0. The total number of data points in the regression is 101,064. For the data set as a whole, the log-odds of a rollover fatality is log (1036/100,028) = -4.57.

Table 3-1 lists the regression coefficients (betas) for the intercept, the **curb weight**, and each of the control variables in the logistic regression analysis on the 101,064 data points. A positive coefficient for the independent variables implies that an increase in the variable is associated with an increase in fatality risk (for ease of interpretation, the signs of the coefficients have been reversed from the way they are presented in printouts of SAS for personal computers).

The regression coefficient for curb weight is -.000248. In other words, a 100 pound weight increase is associated with a 2.5 percent reduction in rollover fatalities. Conversely, a 100 pound weight reduction is associated with a 2.5 percent increase in rollover fatalities. The third column of numbers in Table 3-1, "Wald Chi-Square," attaches a χ^2 value of 6.499 to this coefficient. In other words, the association between car weight and rollover fatality risk is statistically significant ($p = .0108$).

The remainder of Table 3-1 provides regression coefficients for a long list of control variables. All of the coefficients are of plausible magnitude and, if they are significant, they are in the right direction. The great advantage of disaggregate logistic regression is that many independent variables can be used, as long as they are not excessively intercorrelated. The coefficient for YOUNGDRV (young driver) is +.077, and it is highly significant ($\chi^2 = 168.77$, $p < .01$). In other words, for each year that a driver is **younger** than 35, the risk of a rollover fatality (to some occupant of the car, not necessarily the driver) increases by about 8 percent. The coefficient for FEMALE is -.758 ($\chi^2 = 94.31$, $p < .01$). In other words, up to age 45, the rollover risk for female drivers is 1 - exp(-.758) = 53 percent lower than for males of the same age. The coefficients for OLDMAN and OLDWOMAN are both positive and statistically significant. However, the coefficient for OLDMAN is just +.026, indicating only a small increase in rollover fatality risk above age 50 (presumably due to increased vulnerability to injury, not an increase in rollover crashes). The coefficient for OLDWOMAN is +.057, indicating that the difference in rollover risk between males and females, which was so large up to age 45, narrows down

TABLE 3-1

LOGISTIC REGRESSION OF PASSENGER CAR ROLLOVER FATALITIES BY CURB WEIGHT

Dependent Variable: ROLLFAT

ROLLFAT	Count	
0	100028	(induced-exposure involvement)
1	1036	(rollover fatality)

N of Observations: 101064

Analysis of Maximum Likelihood Estimates (Regression Coefficients)

Indep. Variable	Regression Coefficient	Standard Error	Wald Chi-Square	Pr > Chi-Square
INTERCPT	-6.6665	0.3817	305.1196	0.0001
CURBWT	**-0.000248**	**0.000097**	**6.4990**	**0.0108**
YOUNGDRV	+0.0770	0.00593	168.7661	0.0001
OLDMAN	+0.0263	0.00873	9.0482	0.0026
OLDWOMAN	+0.0566	0.00900	39.5268	0.0001
FEMALE	-0.7580	0.0781	94.3139	0.0001
NITE	+2.1919	0.0740	878.5173	0.0001
SPDLIM55	+3.5060	0.0832	1776.5520	0.0
CONVRTBL	+0.9927	0.2273	19.0673	0.0001
TWODOOR	+0.5389	0.0804	44.9526	0.0001
STAWAGON	-0.0470	0.2200	0.0456	0.8309
VEHAGE	+0.0151	0.0225	0.4546	0.5002
BRANDNEW	+0.3752	0.1182	10.0730	0.0015
ILLINOIS	-0.2053	0.1232	2.7771	0.0956
LOUISIAN	+0.2273	0.3130	0.5272	0.4678
MARYLAND	-0.5218	0.1842	8.0219	0.0046
MICHIGAN	+1.5514	0.1362	129.8145	0.0001
MISSOURI	-0.0212	0.1282	0.0272	0.8689
NEWMEXIC	+1.5007	0.1560	92.4925	0.0001
NORTHCAR	+0.4456	0.1536	8.4141	0.0037
OHIO	-0.3528	0.1697	4.3185	0.0377
PENNA	-1.3370	0.1595	70.2462	0.0001
UTAH	+1.8514	0.1490	154.4007	0.0001
CY89	-0.0753	0.1137	0.4379	0.5081
CY90	-0.00129	0.1085	0.0001	0.9905
CY92	-0.0825	0.1096	0.5659	0.4519
CY93	-0.2389	0.1263	3.5774	0.0586
ABS4	+0.4583	0.1580	8.4181	0.0037
AWD	+1.1859	0.3500	11.4807	0.0007
FWD	+0.1186	0.1134	1.0925	0.2959
WET	-1.0564	0.1141	85.6877	0.0001
SNOW_ICE	-1.2335	0.2522	23.9247	0.0001

considerably thereafter.

The coefficients for NITE and SPDLIM55 are very strongly positive (χ^2 = 878.52 and 1776.55, respectively). Relative to **any** measure of exposure, such as mileage, rollovers would be more common at night and on high-speed roads. But the effect is magnified relative to induced exposure. Due to lower traffic density, induced-exposure crashes are less frequent, per mile, at night than during the daytime. Induced-exposure crashes are also less frequent on high-speed roads, especially limited-access roads, than in stop-and-go city driving.

The association of car body style with rollover fatality risk is twofold. In general, two-door cars and, especially, convertibles attract more intense drivers than four-door sedans; station wagons, less intense drivers. That will increase the frequency of rollover crashes for the two-door cars. Additionally, two-door cars and, especially, convertibles expose occupants to a greater risk of fatality, given a rollover. The large doors and windows of a two-door car and, needless to say, the open top of a convertible can be avenues of ejection for unrestrained occupants [18], pp. 218-220. Thus, it is appropriate that large positive coefficients are associated with convertibles (+.99) and two-door cars (+.54), both significant at the .01 level. The risk in station wagons, having been adjusted for driver age, sex and vehicle weight, is essentially the same as for the "baseline" four-door body style.

Vehicle age, for cars one or more years old, does not have a significant association with rollover fatality risk, relative to induced exposure. But cars less than a year old have substantially higher rollover risk, as indicated by the coefficient of +.38 for BRANDNEW. Perhaps that is because drivers are still unfamiliar with the limits of performance of new cars, or because they are extensively used for long intercity trips or pleasure driving.

The ten State variables need to be interpreted carefully. In the revised induced-exposure file, all 11 States have the same **overall** fatality rate, per 1000 induced-exposure crashes. The distribution of fatal crash modes, however, still varies from State to State - e.g., the proportion of fatal crashes that are principal rollovers. Thus, Illinois, Maryland and Ohio, which are more urbanized than Florida (the "baseline" State), tend to have fewer rollovers (as compared to multivehicle or pedestrian fatalities), and get negative regression coefficients. Pennsylvania combines a high degree of urbanization with an abundance of fixed objects (trees) in its rural areas, so it has an even smaller proportion of rollovers, and an even more negative coefficient. Louisiana, North Carolina and, especially, New Mexico and Utah have a high proportion of rollover fatalities, and positive coefficients. Michigan is a special case: since SPDLIM55 had to be set to zero in every record (see Section 2.4), the crashes on high-speed roads (where most rollovers occur) are included in the SPDLIM55 = 0 group, and the proportion of rollovers is high by SPDLIM55 = 0 standards. Calendar year has a negligible effect. The rollover risk in 1989, 1990 and 1992 is about the same as in the "baseline" year of 1991, but the reduction for 1993 comes close to statistical significance (χ^2 = 3.58). ABS is associated with a significant increase in rollover fatality risk. The coefficient, +.46, is consistent with NHTSA's evaluation of ABS, which estimated increases of rollovers in the 25-50 percent range [20], pp. 105-108. Four-wheel drive (AWD) cars, which are used extensively on rural and unimproved roads, have substantially higher rollover fatality risk, but front-wheel drive cars have about the same risk as "baseline," rear-wheel drive cars. Adverse road (and weather) conditions (WET, SNOW_ICE) substantially depressed rollover risk relative to induced exposure. These conditions do not necessarily reduce rollovers; they just greatly increase induced-exposure involvements, because drivers may have more difficulty seeing stopped vehicles, and they certainly have less braking and handling capability to avoid hitting them.

3.4 Regressions on the size of the "case" passenger car

Logistic regressions similar to the preceding one were performed for each of the major subgroups of fatal crashes. The results are documented in Table 3-2. In each analysis, the "case" vehicles are passenger cars. The measure of risk (dependent variable) is the total number of fatalities, including occupants of the case vehicles, occupants of other vehicles, and pedestrians, relative to induced exposure. The key independent variables (measures of car size) are curb weight, track width, and/or wheelbase. The other independent variables (control variables) include age and sex of the case vehicle driver, etc.

The analysis reviewed in the preceding section is C1, the first one listed in Table 3-2. The first column, Run Number, was sequentially assigned to allow easy reference to the various analyses. The next column shows the type of fatal crashes analyzed, and their code, as defined in Table 2-1. The third column shows the measure of car size. Thus, regression C1 analyzes rollover risk by curb weight. The fourth column is the main result: the **percentage** change in fatalities associated with a **100 pound reduction of curb weight** (or a 1 inch reduction of track width or wheelbase). Since the regression coefficient for CURBWT in Table 3-1 was -0.000248, the effect of a 100 pound weight **reduction** is a 2.48 percent **increase** in fatalities. The last column displays the Chi-square (χ^2) value for the regression coefficient of the car-size measure. In general, χ^2 has to exceed 3.84 for statistical significance at the .05 level and 6.64 for significance at the .01 level. Thus, the effect of curb weight in analysis C1 is significant at the .05 level.

Rollover stability is believed to be strongly related to track width (relative to the height of the center of gravity) and only indirectly related to curb weight, to the extent that most wide cars are heavy (see Section 1.2). Regression C2 calibrates rollover fatality risk by track width. This regression is set up just like C1, except with TRAKWDTH instead of CURBWT as an independent variable. The effects of the control variables are similar to those in C1. The regression associates a 10.8 percent increase in rollover risk for every inch of reduction in track width. The χ^2 statistics, rather than the coefficients themselves, allow a direct comparison of the relative strengths of the effects. The χ^2 for track width is 31.33, significant at the .01 level, and much stronger than the 6.50 for curb weight.

Wheelbase is strongly correlated with both curb weight and track width. It is also believed to have a direct influence on directional stability, which can be a factor in rollover causation. Regression C3 calibrates rollover risk by wheelbase, estimating a 2.96 percent increase in rollover fatalities per inch of reduction in wheelbase. The χ^2 is 17.19, intermediate between the results for curb weight and track width.

Regressions C1 - C3 make a case that track width is the size parameter most directly associated

TABLE 3-2

PASSENGER CARS: LOGISTIC REGRESSIONS OF FATALITY RISK BY "CASE" VEHICLE SIZE

MEASURE OF RISK: fatalities in the crash, relative to induced exposure
MEASURE OF SIZE: curb weight, track width and/or wheelbase of the passenger car "case" vehicle
CONTROLLING FOR: driver age & sex, car body style & equipment, road & accident conditions, etc.

Run No.	**Crash Type (Codes)**	**Measure of Size (Case Car)**	**Effect per 100 Pound or 1 Inch REDUCTION (%)**	χ^2
C1	principal rollover (11)	WEIGHT	+ 2.48 per 100	6.50
C2	principal rollover (11)	TRACK WIDTH	+10.80 per inch	31.33
C3	principal rollover (11)	WHEELBASE	+ 2.96 per inch	17.19
C4	principal rollover (11)	WEIGHT TRACK WIDTH WHEELBASE	-11.10 per 100 (!?) +18.90 per inch (!?) + 5.34 per inch (!?)	
C5	principal rollover (11) w RURAL control var	WEIGHT	+ 2.62 per 100	6.90
C6	frontal-fixed object (13)	WEIGHT	+ 1.62 per 100	6.53
C7	side-fixed object (14)	WEIGHT	+ 1.34 per 100	2.14
C8	collision-induced rollover (12)	WEIGHT	+ .53 per 100	.22
C9	hit object (12-17, 81)	WEIGHT	+ 1.91 per 100	17.36
C10	hit object (12-17, 81)	TRACK WIDTH	+ 2.69 per inch	9.13
C11	pedestrian, bicycle, motorcycle (21-22)	WEIGHT	- 1.00 per 100	3.45
C12	hit big truck (31-39)	WEIGHT	+ 2.62 per 100	13.12
C13	hit another car (41-59)	WEIGHT	+ .78 per 100	4.57
C14	hit light truck (61-79)	WEIGHT	+ 3.17 per 100	34.53

with rollover risk; curb weight, secondarily, through its correlation with track width. Couldn't a better case be made by putting all three parameters in the same regression? The problem, of course, is that they are highly intercorrelated: among these 1985-93 passenger cars, the correlation coefficients are .86 for curb weight with track width, .89 for curb weight with wheelbase and .79 for track width with wheelbase. When they are entered simultaneously (C4), it leads to typical "wrong signs" and meaningless results: the "effect" for curb weight is a very large 11.1 percent per 100 pounds, in the wrong direction, while the effects for track width and wheelbase, while in the right direction, are double the values in C2 and C3. At least, the results are so obviously wrong that the analyst will not be tempted to rely upon them.

The RURAL control variable is generally omitted from the regressions, as explained in Section 3.3. Regression C5 shows that the addition of RURAL to the independent variables has little effect on the coefficient for curb weight: 2.62, vs. 2.48 in C1.

Regressions C6 - C10 address single-vehicle nonpedestrian crashes other than principal rollovers: primarily impacts with fixed objects. The first question is whether, and how to subgroup these crashes. It is best answered by analyzing some subgroups, and checking if the results are consistent. C6 addresses frontal impacts with fixed objects (crash type 13), by curb weight. The control variables are the same as in C1, except that AIRBAG has been added, since air bags can be expected to reduce risk in frontal crashes. The observed effect is a 1.62 percent increase in fatalities per 100 pound weight reduction. C7 obtains a very similar 1.34 percent effect for curb weight in side impacts with fixed objects (crash type 14). The effects of the control variables in C7 are generally intermediate between C1 and C6. Although frontal and side impacts with fixed objects may be due to different causes (the latter are more likely to involve cars that have spun out of control), the weight effects are consistent.

Collision-induced rollovers (crash type 12) are almost as numerous as principal rollovers (737 vs. 1036 on the analysis file). Most of them involve initial impact with a fixed object. Should they be grouped with the fixed-object impacts or the principal rollovers? Specifically, do the factors that make small cars so vulnerable to principal rollovers also apply to impact-induced rollovers? Regression C8 shows only a .53 percent increase in fatality risk per 100 pound weight reduction, and it suggests these crashes are more appropriately grouped with other fixed-object crashes.

Thus, single-vehicle nonpedestrian crashes other than principal rollovers are a reasonably homogeneous group. In addition to the preceding categories, they include fixed-object impacts with other or unknown damage areas and impacts with trains, animals and unoccupied parked cars (crash types 12-17 and 81 in Table 2-1). Regression C9 associates a 1.91 percent increase in fatality risk per 100 pound reduction in weight. The effect is statistically significant at the .01 level ($\chi^2 = 17.19$), although it is somewhat lower than the 2.48 percent increase in principal rollovers. It is interesting to compare the effects of the control variables in the analyses of principal rollovers (C1) and these crashes: (1) the increase for young drivers is about the same in C1 and C9, but the increase for older drivers is much larger in C9; (2) the trend to higher fatality risk in convertibles, 2-door cars, and brand-new cars is higher for rollovers; (3) heavily forested States, such as Maryland and Pennsylvania, have proportionately more collisions with objects; New Mexico, Utah and Florida have fewer. All differences are in the expected direction.

C10, like C9, analyzes single-vehicle nonpedestrian crashes other than principal rollovers, but the measure of car size is track width rather than curb weight. The association of fatality risk with track width is statistically significant, but the χ^2 value is 9.13, which is only about half the 17.19 in the regression by curb weight. This is quite a contrast with C1 and C2, where the regression of rollovers by curb weight had $\chi^2 = 6.50$, but by track width, 31.33. In other words, since curb weight and track width are highly correlated, any fatality risk significantly correlated with one of the size parameters will also be correlated with the other one. Nevertheless, rollover risk appears to be driven primarily by track width, while risk in impacts with objects is primarily driven by curb weight.

Pedestrians, bicyclists, other nonoccupants (equestrians) and motorcyclists are a homogeneous group in that they are all smaller than passenger cars. Very few of the fatalities in collisions between passenger cars and these road users are passenger car occupants. Intuitively, a reduction in passenger car weight might even help a pedestrian or motorcyclist survive a crash, or it might make it easier for the car to steer around the pedestrian. Mengert and Borener's models suggested that reductions in car weight reduce fatality risk in pedestrian collisions (see Section 1.5). Regression C11 supports that finding: it associates a 1 percent **reduction** in fatality risk with a 100 pound reduction in car weight. The χ^2 value is 3.45, which falls just short of statistical significance. The effects of the control variables are listed in Table 3-3. They differ from those in the analyses of principal rollovers (C1), as follows: (1) pedestrian crashes are more of a problem with old than with young car drivers, whereas rollovers were primarily a young-driver problem (pedestrian impacts are less the result of aggressive driving than inattentive or unskilled driving); (2) the effect of SPDLIM55 is much less here: rollovers are most common on high-speed roads, but pedestrian crashes are most frequent in urban areas; (3) 2-door cars are only slightly overinvolved in pedestrian crashes, and brand-new cars, not at all; (4) Florida, with its abundance of bicyclists, motorcyclists and elderly pedestrians, has higher fatality rates for these crashes than almost every other State; (5) ABS, which was associated with a substantial increase in rollovers, shows a substantial benefit here. Again, all of the differences are in the expected direction.

By contrast, when cars collide with big trucks or buses (over 10,000 pounds GVW), almost all of the fatalities are in the cars. Regression C12 shows that a 100 pound weight reduction for passenger cars is associated with a substantial 2.62 percent increase in fatality risk. The effect is statistically significant at the .01 level ($\chi^2 = 13.12$). The coefficients for the control variables indicate that older drivers of passenger cars are especially prone to collisions with big trucks, and that air bags and ABS in the cars reduce the fatality risk.

The same method can be used to analyze collisions between a car and another light vehicle: a car or a light truck. Curb weight, driver age, etc. for the "case" vehicle are entered into the regression, while the "other" vehicle is treated as a "black box" of unknown weight, driver age, etc., just as in the preceding analysis of collisions of cars with big trucks. Whereas the preferred method is to analyze the effects of the weight, driver age, etc. for both vehicles (as will be done in Sections 3.6 - 3.8), this method at least has the advantage of including accident cases where all the variables are known for just one of the two vehicles - e.g., collisions between a 1985-93 car and a pre-1985 car.

TABLE 3-3

LOGISTIC REGRESSION OF THE FATALITY RATE IN IMPACTS OF PASSENGER CARS WITH PEDESTRIANS, BICYCLISTS OR MOTORCYCLISTS, BY CURB WEIGHT OF THE CAR

Dependent Variable: PEDFAT

PEDFAT	Count	
0	100028	(induced-exposure involvement)
1	2858	(pedestrian, bicyclist or motorcyclist fatality)

N of Observations: 102886

Analysis of Maximum Likelihood Estimates (Regression Coefficients)

Indep. Variable	Regression Coefficient	Standard Error	Wald Chi-Square	Pr > Chi-Square
INTERCPT	-4.6169	0.2123	473.1247	0.0001
CURBWT	**+0.000100**	**0.000053**	**3.4518**	**0.0632**
YOUNGDRV	+0.0350	0.00354	97.5527	0.0001
OLDMAN	+0.0363	0.00354	105.2068	0.0001
OLDWOMAN	+0.0571	0.00357	256.6122	0.0001
FEMALE	-0.5671	0.0455	155.0002	0.0001
NITE	+1.7276	0.0404	1827.9444	0.0
SPDLIM55	+1.1874	0.0499	565.2794	0.0001
CONVRTBL	-0.1459	0.1956	0.5561	0.4558
TWODOOR	+0.1157	0.0450	6.6278	0.0100
STAWAGON	-0.1256	0.1011	1.5435	0.2141
VEHAGE	+0.0588	0.0123	22.9952	0.0001
BRANDNEW	-0.0197	0.0766	0.0662	0.7969
ILLINOIS	-0.4025	0.0695	33.5727	0.0001
LOUISIAN	-0.2884	0.1857	2.4120	0.1204
MARYLAND	-0.2434	0.0835	8.4996	0.0036
MICHIGAN	-0.1292	0.0800	2.6048	0.1065
MISSOURI	-0.8934	0.0952	88.0728	0.0001
NEWMEXIC	+0.0548	0.1289	0.1809	0.6706
NORTHCAR	-0.2835	0.0962	8.6845	0.0032
OHIO	-0.4362	0.0848	26.4898	0.0001
PENNA	-0.3955	0.0602	43.2028	0.0001
UTAH	-0.1747	0.1387	1.5870	0.2078
CY89	+0.0819	0.0652	1.5807	0.2087
CY90	+0.1104	0.0622	3.1500	0.0759
CY92	-0.0490	0.0616	0.6340	0.4259
CY93	-0.0103	0.0675	0.0231	0.8791
ABS4	-0.3229	0.1067	9.1538	0.0025
AWD	+0.2789	0.2504	1.2404	0.2654
FWD	+0.1042	0.0634	2.6996	0.1004
WET	-0.7988	0.0581	189.1855	0.0001
SNOW_ICE	-1.1138	0.1800	38.2880	0.0001

Regression C13 analyzes crashes in which the "case" car hit another passenger car. A 100 pound reduction for the "case" car (while the "other" car remains an unchanged "black box") is associated with a modest 0.78 percent increase in fatality risk in the collision (occupants of either vehicle), statistically significant at the .05 level ($\chi^2 = 4.57$). From this result, it may be inferred that if **both** cars in the collision were reduced by 100 pounds, the increase in fatality risk would be twice as large (approximately 1.56 percent). The coefficients for the control variables indicate that car-to-car collisions are more of an older-driver than a young-driver problem; female drivers have lower risk than males, but the difference is not as large as in rollovers and fixed-object crashes.

When the "other" vehicle is a light truck, regression C14 associates a 3.17 percent increase in fatality risk for every 100 pound reduction in the weight of the "case" passenger car. The effect is statistically significant at the .01 level ($\chi^2 = 34.53$), and it is the highest effect for curb weight in any of the regressions of Table 3-2. The coefficients of the control variables are almost the same as in the car-to-car analysis (C13). Table 3-2 is the first indication, in this report, that passenger cars may have substantial size-safety problems in collisions with big trucks and light trucks.

3.5 Regressions on the size of the "case" light truck

When the "case" vehicle is a light truck rather than a passenger car, the analysis method is essentially the same. Table 3-4, for example, illustrates the analysis of light truck rollovers by curb weight. The measure of risk (dependent variable) is still the total number of fatalities in the crash, relative to induced exposure. The key independent variables are curb weight, track width, or wheelbase. The control variables are the same as for passenger cars, except the following: car body style is replaced by truck type, which is expressed as two dichotomous variables, SUV and VAN (both of which are set to zero if the case vehicle is a pickup truck). Two distinct types of ABS exist for light trucks: rear-wheel and four-wheel. ABS2 = 1 for trucks equipped with the rear-wheel system; ABS4 = 1 on trucks with four-wheel systems. Since fewer than 2 percent of 1985-93 trucks were equipped with air bags, the AIRBAG variable was not used, since it would add little to the model. AWD, indicating four-wheel drive, is kept in the model, but FWD is dropped because the only trucks with front-wheel drive are compact vans.

There were 991 principal rollover crashes of light trucks, resulting in 1076 fatalities (data points with ROLLFAT = 1). The revised induced-exposure data base contains 50,037 records; 89 pickup-cars (such as Chevrolet El Camino and Subaru Brat) are excluded, leaving 49,948 induced-exposure involvements of "true" light trucks (data points with ROLLFAT = 0). Logistic regression is applied to the combined file of 51,024 data points, as shown in Table 3-4.

The unadjusted fatality rates discussed in Section 2.6 suggested that the weight-safety relationship is quite different for light trucks and cars, at least **relative to induced exposure**. Table 3-4 confirms that finding for rollovers. The regression coefficient for CURBWT is +.000080. In other words, a 100 pound weight reduction is associated with a 0.8 percent **reduction** in rollover fatalities, relative to induced exposure. The effect is not statistically significant ($\chi^2 = 1.42$).

TABLE 3-4

LOGISTIC REGRESSION OF LIGHT TRUCK ROLLOVER FATALITIES, BY CURB WEIGHT

Dependent Variable: ROLLFAT

ROLLFAT	Count	
0	49948	(induced-exposure involvement)
1	1076	(rollover fatality)

N of Observations: 51024

Analysis of Maximum Likelihood Estimates (Regression Coefficients)

Indep. Variable	Regression Coefficient	Standard Error	Wald Chi-Square	Pr > Chi-Square
INTERCPT	-6.7117	0.2621	655.8354	0.0001
CURBWT	**+0.000080**	**0.000067**	**1.4238**	**0.2328**
YOUNGDRV	+0.0783	0.00600	170.5699	0.0001
OLDMAN	+0.0471	0.00866	29.5762	0.0001
OLDWOMAN	+0.0751	0.0135	30.7582	0.0001
FEMALE	-0.2434	0.0929	6.8617	0.0088
NITE	+2.0944	0.0744	793.4710	0.0001
SPDLIM55	+3.6376	0.0871	1743.3080	0.0
SUV	+0.3221	0.0986	10.6739	0.0011
VAN	-0.1641	0.1150	2.0350	0.1537
VEHAGE	+0.0586	0.0258	5.1609	0.0231
BRANDNEW	+0.4372	0.1240	12.4243	0.0004
ILLINOIS	-0.5742	0.1452	15.6421	0.0001
LOUISIAN	-0.3979	0.2806	2.0100	0.1563
MARYLAND	-1.2267	0.2291	28.6802	0.0001
MICHIGAN	+1.0160	0.1549	43.0030	0.0001
MISSOURI	-0.3927	0.1270	9.5599	0.0020
NEWMEXIC	+0.9670	0.1253	59.5624	0.0001
NORTHCAR	-0.1954	0.1664	1.3800	0.2401
OHIO	-0.9252	0.1866	24.5737	0.0001
PENNA	-1.4382	0.1567	84.2348	0.0001
UTAH	+1.2020	0.1500	64.2563	0.0001
CY89	-0.0663	0.1183	0.3135	0.5755
CY90	-0.1098	0.1137	0.9334	0.3340
CY92	-0.3012	0.1147	6.8983	0.0086
CY93	-0.2011	0.1264	2.5292	0.1118
ABS2	+0.0295	0.1009	0.0853	0.7702
ABS4	-0.2617	0.3068	0.7276	0.3937
AWD	+0.2601	0.0975	7.1221	0.0076
WET	-1.0428	0.1185	77.3807	0.0001
SNOW_ICE	-0.3757	0.1861	4.0764	0.0435

Unlike curb weight, the coefficients of the control variables closely parallel the results for passenger car rollovers (Table 3-1). The coefficients are nearly the same for young drivers (.0783 vs. .0770), NITE, SPDLIM55, BRANDNEW, CY and WET. The coefficients for older drivers, females and the various States, although differing in magnitude, preserve their earlier pattern. The new control variables have plausible effects: SUV and AWD are associated with higher rollover risk, VAN with lower risk, and the two types of ABS have nonsignificant effects. In that sense, the regression model "works" for light trucks.

Thirteen logistic regressions for light trucks, comprising rollovers and the other major subgroups of fatal crashes, are documented in Table 3-5. The results are obviously different from cars (Table 3-2). Whereas every regression for cars, except in pedestrian crashes, showed increasing risk when weight was reduced, most of the light truck analyses show **diminishing** risk as weight is reduced.

Regressions T1 - T3 analyze principal rollovers. T1 is the analysis by curb weight, discussed above. T2 computes the effect of track width (which, for passenger cars, was much stronger than the effect of curb weight: 10.80 percent fatality increase per inch reduction). Here, the trend is in the same direction. A reduction in track width is associated with an increase in light truck rollover fatalities, but just barely: 0.77 percent per inch. The effect is not significant ($\chi^2 = .73$). Wheelbase (T3) has a slightly stronger effect, as evidenced by the $\chi^2 = 3.27$, but it is still not statistically significant.

T4 analyzes nonpedestrian single-vehicle crashes other than principal rollovers (crash types 12-17 and 81). It is equivalent to analysis C9 for cars. For light trucks, a 100 pound reduction was associated with a 1.30 percent decrease in fatality risk. Pedestrian, bicyclist and motorcyclist fatalities decreased even when car weight was reduced (by 1.00 percent, analysis C11); with light trucks (T5), the decrease relative to induced exposure is a dramatic 4.40 percent per 100 pounds ($\chi^2 = 80.07$). The only type of crash where fatalities increase as light truck weight decreases is the collision with big trucks (T6), and the effect of 0.49 percent per 100 pounds is not statistically significant ($\chi^2 = .37$). In all of these analyses, as for rollovers, the coefficients of the control variables are plausible, and they generally parallel those for passenger cars.

Regressions T7 and T8 analyze collisions between a light truck and another light vehicle: the "other" vehicle is treated as a "black box" of unknown weight, driver age, etc. T7 analyzes crashes in which the "case" light truck hit a passenger car. A 100 pound reduction for the light truck (while the car remains an unchanged "black box") is linked with a substantial 3.40 percent reduction of fatalities in the collision, statistically significant at the .01 level ($\chi^2 = 101.91$). Most of the fatalities in these collisions are occupants of the passenger cars.

In collisions between two light trucks, regression T8 associates a 3.30 percent decrease in fatality risk for every 100 pound reduction in the weight of the "case" light truck. The effect is statistically significant at the .01 level ($\chi^2 = 31.96$). From this result, it may be inferred that if **both** light trucks in the collision were reduced by 100 pounds, the reduction in fatality risk would be twice as large (approximately 6.6 percent). While that conclusion may be true **relative to reported induced exposure**, it is absurd in any "real" sense. There is simply no way that a collision between two 3900 pound pickup trucks is intrinsically twice as dangerous as a collision

TABLE 3-5

LIGHT TRUCKS: LOGISTIC REGRESSIONS OF FATALITY RISK BY "CASE" VEHICLE SIZE

MEASURE OF RISK: fatalities in the crash, relative to induced exposure
MEASURE OF SIZE: curb weight, track width and/or wheelbase of the light truck "case" vehicle
CONTROLLING FOR: driver age & sex, light truck type & equipment, road & accident conditions, etc.

Run No.	**Crash Type (Codes)**	**Measure of Size (Case Trk)**	**Effect per 100 Pound or 1 Inch REDUCTION (%)**	χ^2
T1	principal rollover (11)	WEIGHT	- .80 per 100	1.42
T2	principal rollover (11)	TRACK WIDTH	+ .77 per inch	.73
T3	principal rollover (11)	WHEELBASE	+ .68 per inch	3.27
T4	hit object (12-17, 81)	WEIGHT	- 1.30 per 100	6.84
T5	pedestrian, bicycle, motorcycle (21-22)	WEIGHT	- 4.40 per 100	80.07
T6	hit big truck (31-39)	WEIGHT	+ .49 per 100	.37
T7	hit car (41-59)	WEIGHT	- 3.40 per 100	101.91
T8	hit another light truck (61-79)	WEIGHT	- 3.30 per 100	31.96
T9	principal rollover (11) w RURAL control var	WEIGHT	- .70 per 100	1.03
T10	object, ped, bike, MC big truck (12-39, 81)	WEIGHT	- 2.30 per 100	47.03
T11	object, ped, bike, MC big truck (12-39, 81) w RURAL control var	WEIGHT	- 2.30 per 100	44.42
T12	principal rollover (11) trucks ≤ 4000 pounds	WEIGHT	- .70 per 100	.36
T13	object, ped, bike, MC big truck (12-39, 81) trucks ≤ 4000 pounds	WEIGHT	- 2.10 per 100	14.60

between two 2800 pound pickup trucks ($1.066^{11} = 2.02$): intuition suggests the risks should be fairly similar. Thus, regression T8 is perhaps the plainest evidence that the induced-exposure method does not accurately estimate "true" size-safety relationships, at least for light trucks.

It is interesting to compare the effects of 100 pound reductions of curb weight in corresponding regressions for cars and light trucks:

	Passenger Cars		Light Trucks		PC - LT
Principal rollover	(C1)	+2.48	(T1)	- .80	3.28
Hit object	(C9)	+1.91	(T4)	-1.30	3.21
Ped-bike-motorcycle	(C11)	-1.00	(T5)	-4.40	3.40
Hit big truck	(C12)	+2.62	(T6)	+ .49	2.13
Hit one of its own kind	(C13)	+ .78	(T8)	-3.30	4.08

The observed effect for light trucks is 2.13 to 4.08 percent more negative per 100 pounds than the effect for cars. It is not clear whether there are genuine differences in the size-safety effects of cars and trucks, or biases in the induced-exposure method, or both.

Regressions T9 - T13 examine two possible sources of bias. Could it be that the larger trucks are used more in rural areas, where the crashes are more severe? The inclusion of the RURAL control variable in the analysis of principal rollovers (T9) does not really change the results from T1. Similarly, analyses of collisions with objects, pedestrians or big trucks (crash types 12-39 and 81) produced identical coefficients for curb weight with (T11) and without (T10) the RURAL control variable.

The unadjusted fatality rates in Figure 2-4 seemed to show especially high fatality rates above 4000 pounds. Perhaps there is some unique underreporting problem for the induced-exposure crashes of the largest light trucks. Nevertheless, even when trucks over 4000 pounds are excluded from the regression analyses of rollovers (T12) and collisions with objects, pedestrians or big trucks (T13), there is no real change in the coefficient for curb weight. Also, a detailed examination of induced-exposure cases by State, truck type and curb weight did not show any anomalies (such as sparse or missing cases above a certain weight) for any particular group of trucks in any State, or even a strong overrepresentation of the larger trucks in rural areas.

If there is a weight-related bias in the reporting of induced-exposure crashes of light trucks, it appears to be across the board. It is not confined to trucks above some specific minimum weight, but tends to get gradually stronger as truck weight increases. As discussed in Section 1.4, the larger light trucks are rugged, and they are not easily damaged enough to require reporting of the accident. Owners are not always fastidious about the appearance of these trucks, and they may choose not to report minor, borderline-reportable damages. Finally, "induced-exposure" crashes involve a truck standing still and being hit by somebody else. The larger light trucks may have fewer induced-exposure involvements because they are highly visible and look a bit dangerous, motivating other road users to keep a safe distance from them.

There is little doubt that the induced-exposure method produces biased results for light trucks. However, **it would be wishful thinking to assume that the results for cars are unbiased because they "look right,"** and only the results for trucks are biased, because they "look wrong." Any conclusions on the validity of the induced-exposure method have to be postponed to Chapter 4, where the rate of reported induced-exposure crashes, per million vehicle years, is computed by vehicle weight. Those analyses will reveal if the rate decreases as car and/or truck weight increases.

3.6 Regressions on the weight of both vehicles: car-to-car

The preferred analysis of the weight-safety relationship in two-vehicle crashes is to calibrate the fatality risk as a function of the weight of **each** vehicle, controlling for the age and sex of each driver, etc., plus accident factors such as the time of day and speed limit. Intuitively, this is more precise than using only the information on the "case" vehicle and treating the "other" vehicle as a "black box" of unknown weight, driver age, etc. A two-vehicle regression is especially desirable for differentiating the weight-safety effects of the striking and the struck vehicle in a front-to-side impact, or other collision modes where one vehicle strikes and the other is struck. The "failures" in these regression analyses are the fatal two-vehicle crashes, but what are the "successes"?

Each record of a fatal two-car collision will consist of three groups of variables: (1) accident-level variables, such as State, NITE, SPDLIM55; (2) information on the "case" vehicle and its driver (curb weight, age, sex, etc.); (3) information on the "other" vehicle and its driver. The file of induced-exposure involvements, on the other hand, has only one vehicle per record. The first task is to transform the induced-exposure data into a two-car file having the same record structure as the fatal two-car collisions.

The revised induced-exposure file of passenger cars (100,114 records) was classified by the five categorical accident-level variables: calendar year, State, SPDLIM55, NITE and road surface. For any set of specific values for those five variables (e.g., 89, Florida, < 55, daytime, dry), there is a pool of induced-exposure vehicle involvements. By simple random sampling without replacement, pairs of cars are selected from the pool, until none remain (or the last one is discarded, if there are an odd number). Each selected pair of cars, together with the accident-level variables, constitutes a "two-car induced-exposure record." The file has 49,950 pairs of cars (214 of the 100,114 original records were not used because they were the last one in a pool with an odd number of cases).

The rationale for the original induced-exposure method was that a vehicle hit while standing still, just because "it was there," was a surrogate for exposure. The induced-exposure involvements measured how often a vehicle of a specific type "was there" - i.e., at a specific calendar year, State, time of day, etc. - where it could be hit by other vehicles. The rationale for the two-vehicle induced-exposure file is that it contains pairs of vehicles that "were there" - at the same calendar year, State, time of day, etc. If all vehicles that "are there" (at a specific CY, State, etc.) have equal likelihood of getting into fatal crashes with one another, the fatal two-car collision file would have about the same vehicle distribution as the two-vehicle induced-exposure file. The regression analyses will indicate what combinations of vehicles are overinvolved in fatal crashes relative to induced exposure. Of course, the caveats about possible biases with the induced-exposure method apply here, too.

Table 3-6 illustrates the analysis of two-car front-to-side impacts, by the curb weight of each car. The file of fatal accidents involving **two** 1985-93 vehicles, with full information about both vehicles and both drivers (see Section 2.5) contained 806 records of actual collisions between two 1985-93 passenger cars in which the front of the "case" vehicle impacted the side of the "other" vehicle. These 806 crashes resulted in 925 occupant fatalities in one car or the other. So there are 925 data points with the dependent variable, TWOCAR = 1. The 49,864 records on the two-car induced-exposure file with known curb weights for both cars are the data points with the dependent variable TWOCAR = 0. The total number of data points in the regression is 50,789.

The lower half of Table 3-6 lists the independent variables and their regression coefficients. The accident-level variables, such as NITE, SPDLIM55, ILLINOIS, CY89, WET and SNOW_ICE are the same as in earlier analyses, such as Table 3-1. Each vehicle and driver-level variable, on the other hand, appears twice: once for the "case" vehicle and once, immediately following, the corresponding variable for the "other" vehicle. For example, CURBWT is the weight of the frontally impacting "case" vehicle; OCURBWT is the weight of the side-impacted "other" vehicle.

The side of a car is far more vulnerable than the front. In front-to-side collisions, the overwhelming majority of the fatalities are occupants of the cars that were struck in the side. The regression coefficient for CURBWT is +.000520. In other words, a 100 pound weight increase in the frontally impacting vehicle is associated with a 5.2 percent increase in the fatalities in the crash. The coefficient for OCURBWT is -.000542: a 100 pound increase in the struck vehicle reduces fatalities by 5.4 percent. These coefficients make sense: since most of the fatalities are in the side-impacted vehicle, the best strategy is to make the striking vehicle lighter and the struck vehicle heavier.

The regression coefficients for the control variables are also plausible. The coefficient for YOUNGDRV is higher than for OYOUNG, but both are positive: young drivers are especially likely to get involved as the frontally-impacting vehicle, but they are also more likely than 40-year-old drivers to commit errors that result in being struck. Conversely, the coefficients for OLDMAN and OLDWOMAN are small, but the coefficients for OOLDM (.1148) and OOLDF (.1058) are the largest in any of the regressions: older drivers are prone to turn or enter intersections before traffic has cleared, and get hit in the side - and, given a side impact, their fatality risk is high. ABS4 has a substantial negative coefficient but OABS4 does not: ABS can help prevent a fast-moving vehicle from striking somebody else, but it usually can't prevent a slow-moving car from getting struck.

Six logistic regressions of car-to-car crashes are documented in Table 3-7, indicating the safety effects of 100 pound reductions in the weight of the "case" car (CV WEIGHT) and the weight of the "other" car (OV WEIGHT). The first analysis, CC1, includes all collisions between two 1985-93 passenger cars. It is a "symmetric" analysis in that every fatal crash is used twice: once with car no. 1 (as assigned, perhaps arbitrarily, by the FARS analyst) as the "case" vehicle and

TABLE 3-6

LOGISTIC REGRESSION OF TWO-CAR FRONT-TO-SIDE IMPACT FATALITIES, BY CURB WEIGHT OF EACH CAR
(case vehicle's front hit other vehicle's side)

Dependent Variable: TWOCAR

TWOCAR	Count	
0	49864	(two-car "induced-exposure" data points)
1	925	(fatalities in front-to-side impacts)

N of Observations: 50789

Analysis of Maximum Likelihood Estimates (Regression Coefficients)

Indep. Var.	Regr. Coeff.	χ^2	Pr > χ^2	Indep. Var.	Regr. Coeff.	χ^2	Pr > χ^2
INTERCPT	-5.4295	106.11	0.0001	ILLINOIS	-0.3601	7.38	0.0066
CURBWT	+0.000520	29.52	0.0001	LOUISIAN	+0.6889	5.80	0.0160
OCURBWT	-0.000542	32.63	0.0001	MARYLAND	+0.2381	2.74	0.0977
YOUNGDRV	+0.0636	103.94	0.0001	MICHIGAN	+0.6533	24.98	0.0001
OYOUNG	+0.0440	38.31	0.0001	MISSOURI	-0.6578	17.29	0.0001
OLDMAN	+0.0120	2.90	0.0887	NEWMEXIC	-1.6587	7.99	0.0047
OOLDM	+0.1148	641.23	0.0001	NORTHCAR	-0.3937	4.92	0.0265
OLDWOMAN	+0.0447	45.27	0.0001	OHIO	-0.2832	4.09	0.0432
OOLDF	+0.1058	442.36	0.0001	PENNA	-0.3014	7.61	0.0058
FEMALE	-0.5827	53.05	0.0001	UTAH	-0.8785	5.66	0.0173
OFEMALE	-0.4627	25.84	0.0001	CY89	+0.0215	0.03	0.8562
NITE	+0.9853	157.23	0.0001	CY90	-0.1857	2.42	0.1197
SPDLIM55	+1.9160	557.13	0.0001	CY92	+0.0134	0.01	0.9041
CONVRTBL	-0.0985	0.10	0.7544	CY93	+0.2283	3.67	0.0555
OCV	+0.0382	0.01	0.9180	ABS4	-0.3080	3.60	0.0577
TWODOOR	-0.0850	1.06	0.3025	OABS4	-0.0535	0.09	0.7681
O2D	+0.1746	4.42	0.0355	AWD	+0.5158	1.25	0.2639
STAWAGON	-0.3218	3.08	0.0791	OAWD	+1.8934	3.47	0.0623
OSW	+0.1278	0.60	0.4376	FWD	+0.0472	0.18	0.6694
VEHAGE	+0.0422	3.76	0.0524	OFWD	-0.2268	3.81	0.0510
OVEHAGE	+0.0159	0.54	0.4620	WET	-0.1280	2.18	0.1397
BRANDNEW	+0.3790	9.30	0.0023	SNOW_ICE	+0.6965	17.06	0.0001
ONEWVEH	-0.0957	0.48	0.4887				

TABLE 3-7

CAR-TO-CAR COLLISIONS: LOGISTIC REGRESSIONS OF FATALITY RISK BY THE WEIGHT OF EACH VEHICLE

MEASURE OF RISK: fatalities in the crash (occupants of either vehicle), relative to induced exposure
MEASURES OF SIZE: curb weight of the "case" vehicle (CV) **and** curb weight of the "other" vehicle (OV)
CONTROLLING FOR: each driver's age & sex, each car's body style & equipment, road & accident conditions, etc.

Run No.	**Crash Type (Codes)**	**Measure of Size**	**Effect per 100 Pound REDUCTION (%)**	χ^2
CC1	all car-car collisions (41-59)	CV WEIGHT	+ 1.32	6.54
		OV WEIGHT	+ 1.20	5.37
CC2	CV's front hit OV's side (47, 48)	CV WEIGHT	- 5.20	29.52
		OV WEIGHT	+ 5.42	32.63
CC3	front-to-front collisions (41-46)	CV WEIGHT	+ 1.62	4.38
		OV WEIGHT	+ 1.38	3.14
CC4	CV's front hit OV's rear (49)	CV WEIGHT	did not converge	
		OV WEIGHT		
CC5	all except front-to-side (41-46, 49, 52, 54-59)	CV WEIGHT	+ 2.48	12.34
		OV WEIGHT	+ 2.34	10.77

MEASURE OF RISK: fatalities in the **case vehicle**, relative to induced exposure

CC6	front-to-front collisions (41-46)	CV WEIGHT	+ 7.95	55.28
		OV WEIGHT	- 5.70	26.55

car no. 2 as the "other" vehicle, and the other time with these roles reversed. One consequence is that the effects for CV WEIGHT and OV WEIGHT ought to be the same (within the error margin for the logistic regression algorithm) - and they are: a 100 pound reduction in the "case" vehicle is associated with a 1.32 percent increase in fatalities; in the "other" vehicle, 1.20 percent. If all cars on the road are reduced by 100 pounds - i.e., both the "case" and the "other" vehicle - the fatality increase would be about 2.52 percent. Another consequence of the "symmetric" analysis is that the χ^2 statistics shown in Table 3-7 are based on using each accident case twice, so they are twice as high as the data really merit. If the values of 6.54 and 5.37 are halved, they drop out of the significant range.

Regression CC2, the analysis of front-to-side impacts, has already been documented in Table 3-6. It is an "asymmetric" analysis: each fatal crash appears only once, with the frontally impacting (bullet) car as the "case" vehicle and the side-impacted (target) car as the "other" vehicle. Thus, the effects for CV WEIGHT and OV WEIGHT can be, and are quite different, and their χ^2 statistics are "honest." A 100 pound reduction in the bullet car decreases fatalities in the crash by 5.2 percent, statistically significant at the .01 level ($\chi^2 = 29.52$). A 100 pound reduction in the target car increases fatalities by 5.2 percent, also statistically significant at the .01 level ($\chi^2 = 32.63$). However, if all cars on the road are reduced by 100 pounds - i.e., both the "bullet" and the "target" vehicle - these effects almost cancel one another, and the net change in front-to-side fatalities would be close to zero.

CC3 analyzes front-to-front impacts (crash types 41-46). It is a "symmetric" regression, like CC1. A 100 pound reduction in the "case" car, or in the "other" car is associated with about a 1.5 percent fatality increase in the crash. If both cars were reduced by 100 pounds, the net increase would be about 3 percent (unlike front-to-side impacts, where the net effect was close to zero). When the χ^2 statistics are cut in half, these effects are nonsignificant. CC4 attempted to analyze front-to-rear impacts. With only 105 fatalities in those crashes on the file, the logistic regression algorithm was unable to converge to a solution. CC5 is a "symmetric" analysis of all two-car collisions **except** front-to-side impacts (i.e., front-to-front, front-to-rear, and all others): 100 pound reductions in the "case" car, or in the "other" car are associated with statistically significant, and fairly substantial 2.4 percent fatality increases in the crash.

CC6 differs from all preceding analyses, in that the measure of risk is the number of occupant fatalities in the **case** vehicle, relative to induced exposure. All front-to-front crashes are included, as in CC3. However, it has become an "asymmetric" analysis. Although each accident case appears twice on the file, it will only be used twice in the analysis if there are fatalities in both the "case" and the "other" vehicle. The vast majority of fatal crashes result in fatalities in only one of the vehicles, and will only appear in the analysis when the vehicle with the fatalities is the "case" vehicle. CC6 illustrates the overwhelming importance of relative vehicle weight in front-to-front collisions. Each 100 pound reduction in the "case" car increases fatality risk by 7.95 percent for the occupants of that car, but a 100 pound reduction in the "other" car reduces fatality risk by 5.7 percent for the occupants of the "case" car. Both effects are significant at the .01 level ($\chi^2 = 55.28$ and 26.55, respectively). If both cars are reduced by 100 pounds, the net effect is a 2.25 percent fatality increase.

The effects of the control variables in this analysis are plausible. A young driver in the case vehicle has little net effect on fatality risk in the case vehicle, because the increase in accident risk is offset by the greater likelihood of survival, given a crash. A young driver in the other vehicle, however, increases the likelihood that there will be a fatal crash, relative to induced exposure, and that increases fatality risk in the case vehicle. Conversely, the presence of an old driver in the case vehicle (where high accident risk combines with high fatality risk) has a stronger effect on fatality risk in the case vehicle than does the presence of an old driver in the other vehicle. An air bag in the case vehicle reduces fatality risk in that vehicle, but an air bag in the other vehicle has little or no effect on fatality risk in the case vehicle.

3.7 Regressions on the weight of both vehicles: truck-to-truck

Although fatal collisions between two light trucks are not as frequent as between two cars, there are enough cases for regression analyses, using the same methods. The two-light-truck induced-exposure file is constructed by the same procedure as the two-car file, and it has 24,901 records. Table 3-8 documents four analyses of truck-to-truck collisions. The biases in the light-truck data already seen in Table 3-5 extend into all of these analyses, and make it difficult to interpret the results and the χ^2 statistics.

TT1 is a "symmetric" analysis of all collisions between two light trucks. The model associates a 4 percent reduction in fatality risk, relative to induced exposure, per 100 pound reduction in the weight of the "case" truck, and 4.3 percent decrease per 100 pound reduction in the "other" truck. These are even larger reductions than in analysis T8 (Table 3-5). Front-to-side collisions are analyzed in TT2. A 100 pound reduction in the "bullet" truck decreases fatality risk by 7.3 percent. In the target vehicle, fatality risk does not increase (as it ought to), but at least the "reduction" is only 2.6 percent. In front-to-front collisions (TT3), the effect of a 100-pound reduction in either truck is about a 3.2 percent decrease in fatalities in the crash. The effect for occupants of the case vehicle in front-to-front collisions is analyzed in TT4: reducing the case truck by 100 pounds increases the risk to its occupants by 1.17 percent, but reducing the other truck by 100 pounds decreases risk to the case truck occupants by 7 percent. If 4 percent is added to all the effects in Table 3-8, they look somewhat similar to the results in two-car collisions (Table 3-7). That may, however, be a coincidence. At this time, there is no basis for asserting that the actual bias in these light-truck data is 4 percent.

3.8 Regressions on the weight of both vehicles: car-to-truck

The same methods can also be used to perform regression of fatality risk in collisions between a 1985-93 passenger car and a 1985-93 light truck, as a function of the weight of the car and the weight of the truck. Of course, the biases in the light-truck data (and perhaps even in the car data) will extend into these analyses as well, and make it difficult to interpret the results and the χ^2 statistics. Table 3-9 documents four analyses of car-to-truck collisions. They are all "asymmetric" analyses in that each accident case is used only once: with the passenger car as the "case" vehicle and the light truck as the "other" vehicle. (The same collision will also appear in the accident file a second time, with the truck as the "case" vehicle and the car as the "other" vehicle, but that record isn't used here.)

TABLE 3-8

LIGHT TRUCK-TO-LIGHT TRUCK COLLISIONS: LOGISTIC REGRESSIONS OF FATALITY RISK BY THE WEIGHT OF EACH VEHICLE

MEASURE OF RISK: fatalities in the crash (occupants of either vehicle), relative to induced exposure

MEASURES OF SIZE: curb weight of the "case" vehicle (CV) **and** curb weight of the "other" vehicle (OV)

CONTROLLING FOR: each driver's age & sex, each light truck's type & equipment, road & accident conditions, etc.

Run No.	**Crash Type (Codes)**	**Measure of Size**	**Effect per 100 Pound REDUCTION (%)**	χ^2
TT1	all light truck-light truck collisions (61-79)	CV WEIGHT	- 4.00	27.43
		OV WEIGHT	- 4.30	31.16
TT2	CV's front hit OV's side (67, 68)	CV WEIGHT	- 7.30	22.98
		OV WEIGHT	- 2.60	2.25
TT3	front-to-front collisions (61-66)	CV WEIGHT	- 3.00	7.68
		OV WEIGHT	- 3.38	9.08

MEASURE OF RISK: fatalities in the **case vehicle**, relative to induced exposure

TT4	front-to-front collisions (61-66)	CV WEIGHT	+ 1.17	.51
		OV WEIGHT	- 7.00	23.33

TABLE 3-9

CAR-TO-LIGHT TRUCK COLLISIONS: LOGISTIC REGRESSIONS
OF FATALITY RISK BY THE WEIGHT OF EACH VEHICLE

MEASURE OF RISK:	fatalities in the crash (occupants of either vehicle), relative to induced exposure
MEASURES OF SIZE:	curb weight of the passenger car (the "case" vehicle) **and** curb weight of the light truck (the "other" vehicle)
CONTROLLING FOR:	each driver's age & sex, the car's body style & equipment, the light truck's type & equipment, road & accident conditions, etc.

Run No.	**Crash Type (Codes)**	**Measure of Size**	**Effect per 100 Pound REDUCTION (%)**	χ^2
CT1	all car-light truck collisions (61-79)	CAR WEIGHT	+ 2.57	11.46
		TRK WEIGHT	- 2.90	33.44
CT2	car's front hit truck's side (67, 68)	CAR WEIGHT	did not converge	
		TRK WEIGHT		
CT3	car's side hit by truck's front (71, 73)	CAR WEIGHT	+ 2.34	4.53
		TRK WEIGHT	- 4.90	47.19
CT4	front-to-front collisions (61-66)	CAR WEIGHT	+ 2.67	5.65
		TRK WEIGHT	- .80	1.00

The "car-to-light truck induced-exposure file" was constructed as follows. First, the revised induced-exposure files of passenger cars (100,114 records) and light trucks (50,037 records) were combined to make a file of 150,151 vehicle records. This file was classified by the five categorical accident-level variables: calendar year, State, SPDLIM55, NITE and road surface. For any set of specific values for those five variables, there is a pool of induced-exposure vehicle involvements. By simple random sampling without replacement, pairs of vehicles are selected from the pool, until none remain (or the last one is discarded, if there are an odd number). Each selected pair is then inspected: if the first vehicle is a passenger car and the second vehicle is a light truck, the record is retained. Otherwise (if the pair consists of two cars, two trucks, or a truck followed by a car), the record is simply discarded. The file has 16,369 "two-vehicle induced-exposure" records; the first ("case") vehicle on each record is a car, the second ("other") is a light truck.

Regression CT1 includes all collisions in which the case vehicle is a 1985-93 passenger car and the other vehicle is a 1985-93 light truck. A 100 pound reduction of car weight is associated with a 2.57 percent **increase** in fatality risk in the crash, significant at the .01 level ($\chi^2 = 11.46$). But a 100 pound reduction of truck weight is associated with a 2.90 percent **decrease** in fatality risk, also significant at the .01 level ($\chi^2 = 33.44$). These effects make sense: since light trucks are, on the average, 800 pounds heavier than cars, and since most of the fatalities in these crashes are the occupants of the cars, the best strategy for reducing fatalities would be to reduce the weight of the trucks and increase the weight of the cars.

CT2 attempted to analyze crashes in which the front of a car hit the side of a truck. Since those crashes are rarely fatal, there were not enough data for the logistic regression to converge on a solution. But there are many fatalities in crashes where the front of a truck hits the side of a car. Almost all of those fatalities are occupants of the cars. CT3 shows that a 100 pound reduction in the weight of the cars will add another 2.34 percent to their fatality risk, while a 100 pound reduction in the trucks will reduce fatality risk by a substantial 4.90 percent. CT4 analyzes front-to-front collisions between a car and a light truck. Reducing the weights of the cars by 100 pounds does more harm to the car occupants than it benefits the truck occupants, and results in a net fatality increase of 2.67 percent in the crashes. Reducing the weights of the trucks by 100 pounds does more good for the car occupants than it does harm for the truck occupants, and fatality risk decreases by 0.80 percent in the crashes. In general, the results for the car-to-truck collisions appear to have less bias than the earlier results for light trucks, but that does not necessarily mean they are unbiased.

CHAPTER 4

INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE YEARS IN 11 STATES

4.1 Analysis objective

Vehicle registration years are, in many ways, an excellent way to measure exposure. Everybody understands the definition of a vehicle registration year and acknowledges that a vehicle year is, intuitively, a unit of exposure. R. L. Polk's *National Vehicle Population Profile* [26] gives highly accurate estimates of vehicle years, by make-model, model year, body style, calendar year and State. Unfortunately, the registration data have no information on the age and sex of the drivers, or other control variables that would be needed for a meaningful analysis of fatality risk by vehicle weight.

"Induced-exposure crashes," unlike registration years, are not universally accepted as units of exposure, and they can be defined in more than one way (in this report, as vehicles hit while standing still). Their advantage is that the driver's age and sex, plus other control variables such as time of day, speed limit, etc., are known for each crash. Induced exposure, however, is no direct surrogate for vehicle miles or vehicle years. The rate at which vehicles experience induced-exposure crashes can vary considerably, depending on factors such as traffic density. But it was hoped that, at least, the rate was not intrinsically confounded with vehicle size, and that the analysis of fatalities per 1000 induced-exposure crashes, after control for driver age, sex, etc., would produce unbiased estimates of size-safety relationships. The implausible size-safety relationships obtained for light trucks in Chapter 3 have spoiled that hope.

The objective of this chapter is to estimate the extent of size-related bias in fatality rates relative to induced exposure. The strategy is to compute the incidence rate for the questionable exposure measure (induced-exposure crashes) relative to a universally accepted exposure measure (vehicle years) - as a function of vehicle weight, controlling (to the extent possible) for driver age and sex. If the ratio of induced exposure to vehicle years is constant across vehicle weights, then induced exposure may be considered an unbiased surrogate for exposure. If the ratio drifts up or down as weight increases, the extent of the drift measures the bias.

4.2 Polk data reduction

National Vehicle Population Profile data were accessed for the same 11 States, in the same calendar years that are on the induced-exposure accident files (see Section 2.4):

Florida	1989-93	Illinois	1989-92
Louisiana	1990	Maryland	1989-92
Michigan	1989-91	Missouri	1989-93
New Mexico	1989-92	North Carolina	1992-93
Ohio	1991-93	Pennsylvania	1989-93
Utah	1989-93		

The data-reduction task is to translate Polk codes into the make-model and body-style codes on the accident file. There has to be exact correspondence between the files: any vehicle excluded from the accident data has to be excluded from the registration data. Any vehicle included in the accident data has to have an equivalent on the Polk file.

Polk identifies 1985-93 **passenger cars** by their make (MAKE_ABR), model year, model-subseries (SERS_ABR) and body style (STYL_ABR). SERS_ABR is a three-character (generally self-explanatory) code that also appears on FARS, where it is called VINA_MOD. Since FARS also reports the VIN, it can be used to map SERS_ABR onto codes based on the VIN, such as the make-model codes of this report. STYL_ABR is a two-digit code that is easily interpreted for 1985-93 cars. Based on software written for NHTSA's evaluation of the New Car Assessment Program [16], pp. 19-20 and updated for this report, each combination of the Polk codes was associated with a specific combination of the VIN-based codes used on the accident file: the car group (CG), make-model (MM2), body type (BOD2) and model year (MY). Every passenger car on the Polk file was included in the analysis, except low-volume manufacturers (such as Rolls-Royce) and uncommon body styles, such as limousines and incomplete vehicles. Every make-model in Appendix B had an equivalent on the Polk file, and vice-versa (except a 1986 4-door Chevrolet Sprint; also all pre-1988 Hyundai Excel and Mitsubishi Precis were treated as a single make-model, since their VINs are the same).

Polk identifies 1985-93 **light trucks** by their make (MAKE_ABR), model year, model-subseries (MODEL_CD), body style (STYL_ABR) and drive train (WHEELS). MODEL_CD is a four-digit code that does not appear on other files, such as FARS. The digits themselves are not self-explanatory, but Polk's interpretative guide lists make-model names quite comparable to those in *Ward's Automotive Yearbook* [32], or Appendix C of this report. STYL_ABR is a two-character alphanumeric code, with many possible values, and its definition was changed in 1991. Most of the values of STYL_ABR are self-explanatory, allowing exact match-ups with the make-model definitions in Appendix C: including "incomplete vehicles" (STYL_ABR = CB, IC, MI, VI) when, and only when they were included in Appendix C. An exception was that some codes for the larger vans (such as MY = "motor home cutaway") did not appear to correspond exactly with the VIN-based codes of Appendix C. With some reservations about the larger vans (full-sized domestic "20" and "30" series), each combination of the Polk codes was associated with a specific combination of the VIN-based codes used on the accident file: the car group (CG), make-model (MM2) and model year (MY). Every make-model in Appendix C had an equivalent on the Polk file (except the 1988-93 Mazda 4x4 long-bed pickup truck), and vice-versa.

The extract from the Polk passenger car files used in this chapter consists of six variables: CY (1989-93), STATE (one of the 11 listed above), CG (car group), MM2 (make-model), BOD2 (body style), MY (1985-93), and REGS, the number of registered vehicles, as of July 1 in that calendar year, of the specified CG, MM2, BOD2 and MY. The extract file for light trucks has the same variables, except BOD2. The Polk data for the 11 States included over 85 million vehicle registration years for 1985-93 passenger cars and 32 million for 1985-93 light trucks.

4.3 Unadjusted accident rates per 1000 vehicle years

Before any regression analyses, it is appropriate to inspect the basic vehicle-weight trend in the data. The induced-exposure crash involvements and the registration data are grouped by vehicle weight, and the simple, unadjusted rate of induced-exposure crashes per 1000 vehicle years is calculated and graphed for each class interval of vehicle weight. All accident rates in this chapter are based on the full, original induced-exposure files of 559,871 passenger cars and 188,629 light trucks, not on the reduced files used in Chapter 3.

Figure 4-1 graphs the induced-exposure accident rate for **passenger cars** by vehicle weight. Cars were grouped into 100-pound weight intervals (or 300 pound intervals at the upper and lower ends, where the data are sparser), with centroids ranging from 1800 to 4100 pounds. The vertical axis is the logarithm of the accident rate. Figure 4-1 shows a very clear trend of reduced accidents as weight increases, about a 2 percent reduction (i.e., a .02 decrease in the logarithm) per 100 pounds. At first glance, then, induced-exposure crashes are not an unbiased measure of exposure, because if they were, the rate should have been constant across car weights. However, for passenger cars, there is a strong correlation between curb weight and driver age ($r = .30$ on the induced-exposure file), and annual mileage falls sharply as driver age increases. If the data in Figure 4-1 can be adjusted for age and sex, the trend might become much flatter.

Figure 4-2 graphs the accident rate for **pickup trucks**. Here, too, the trend is obviously downwards, and it is even steeper than for passenger cars, about 2.8 percent per 100 pounds. Figure 4-3 shows the rates for **sport utility vehicles**. The data points are more scattered than for pickup trucks, because SUVs are a less numerous and more diverse class of vehicles than pickups, but the downward trend, on the average, is about the same as for pickup trucks.

Figure 4-4, the accident rate for **vans**, reveals a problem. Up to 4000 pounds, the rates have the same decreasing patterns as for pickup trucks and SUVs, but from 4000 pounds onwards (the starred data points), they increase well beyond even those for the lightest vans. It was mentioned above that there were problems relating the Polk codes for the larger vans to the VIN-based codes used on the accident files. Apparently, the data mismatch: there are accident cases involving vans for which there are no corresponding registration data. Thus, the overall accident rate, per 1000 registered vehicles, is high. Since no satisfactory way was found to make the codes compatible, the larger vans cannot be included in analyses that involve registration data. **All the subsequent analyses of this report exclude vans weighing over 4000 pounds.** These large vans constitute about 5 percent of the light trucks on the accident file.

Figure 4-5 graphs the accident rate for all **light trucks**, combined, excluding vans weighing over 4000 pounds. There is a remarkable, almost linear downward trend, running at about 2.7 percent per 100 pounds. It is stronger than the 2.0 percent downward trend in the passenger cars, yet the correlation between curb weight and driver age is weaker for light trucks ($r = .15$) than for cars ($r = .30$). Even after adjustment for driver age, the light truck accident rates are likely to show a substantial downward bias as weight increases.

FIGURE 4-1

PASSENGER CARS
INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE REGISTRATION YEARS
BY CURB WEIGHT

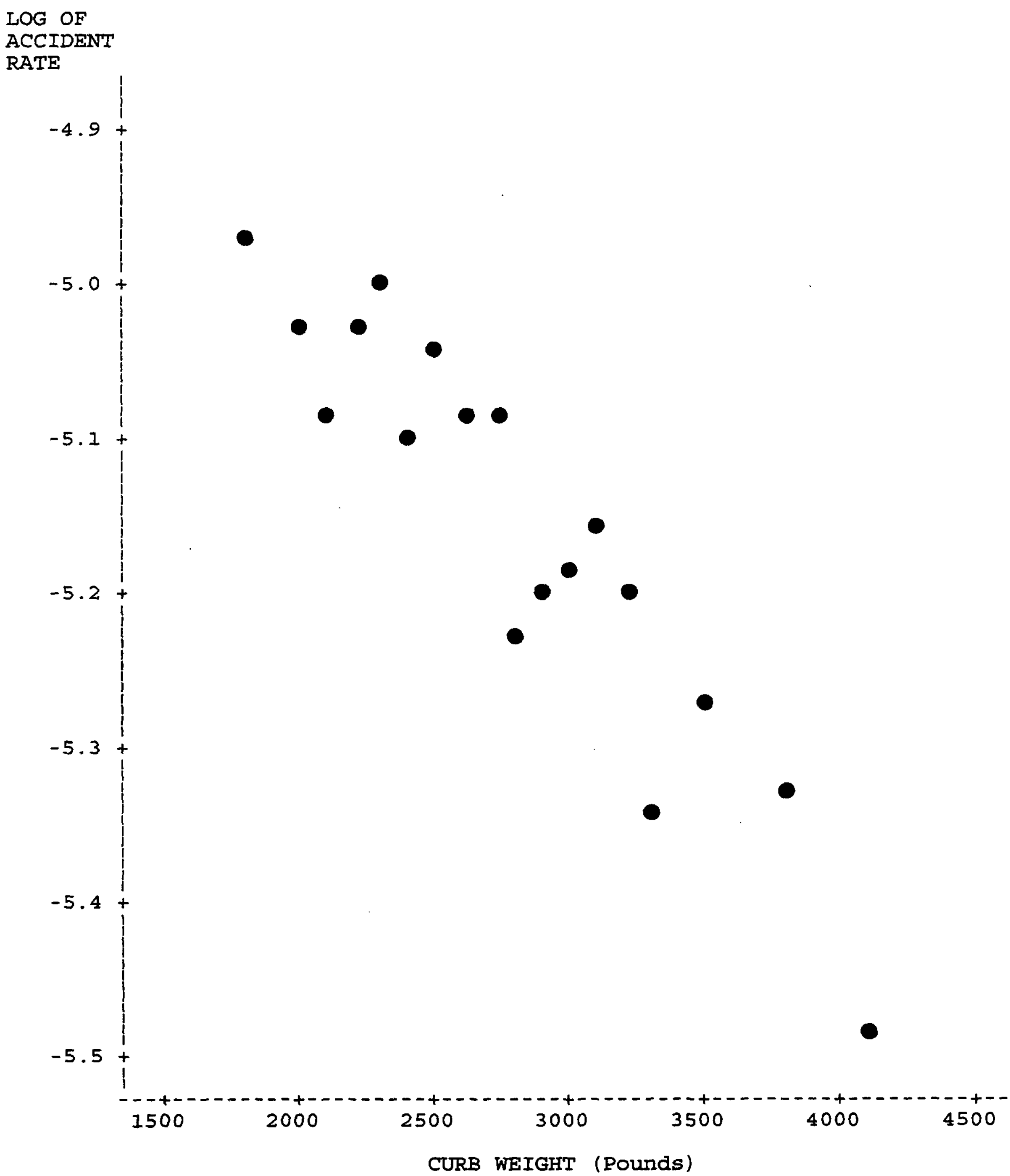


FIGURE 4-2

PICKUP TRUCKS: INDUCED-EXPOSURE CRASHES, PER 1000 VEHICLE REGISTRATION YEARS, BY CURB WEIGHT

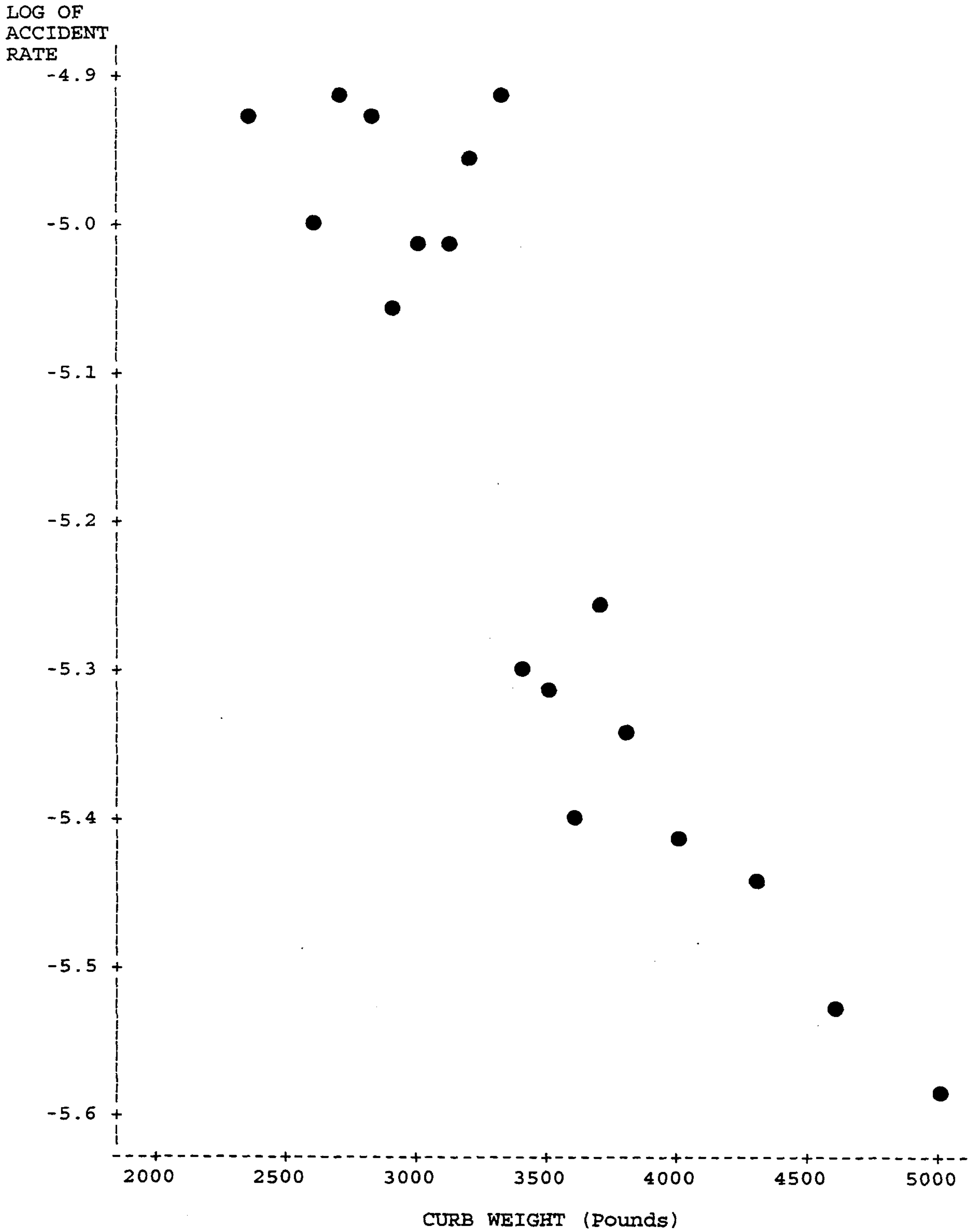


FIGURE 4-3

SPORT UTILITY VEHICLES: INDUCED-EXPOSURE CRASHES, PER 1000 VEHICLE REGISTRATION YEARS, BY CURB WEIGHT

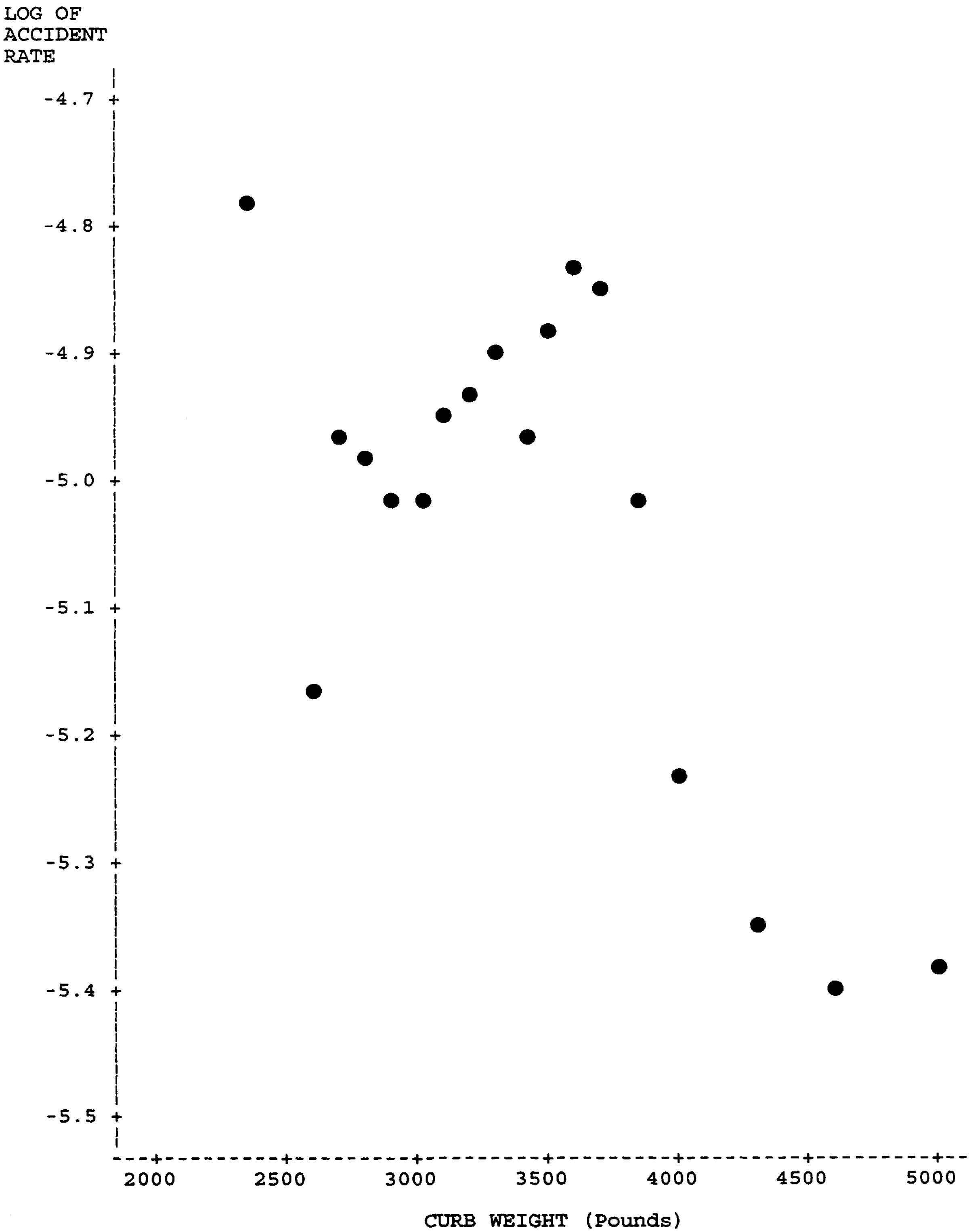


FIGURE 4-4

VANS: INDUCED-EXPOSURE CRASHES,
PER 1000 VEHICLE REGISTRATION YEARS, BY CURB WEIGHT

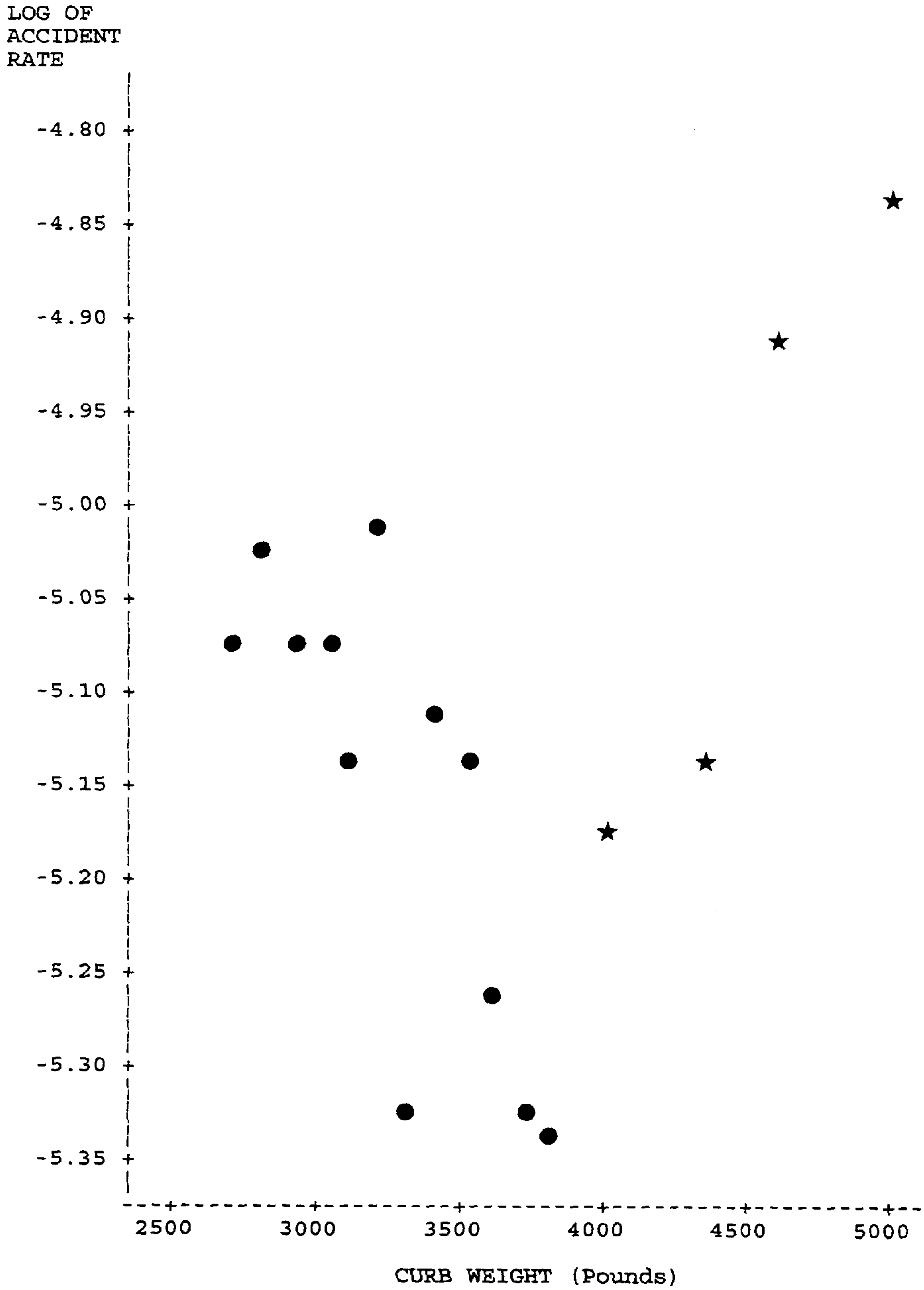
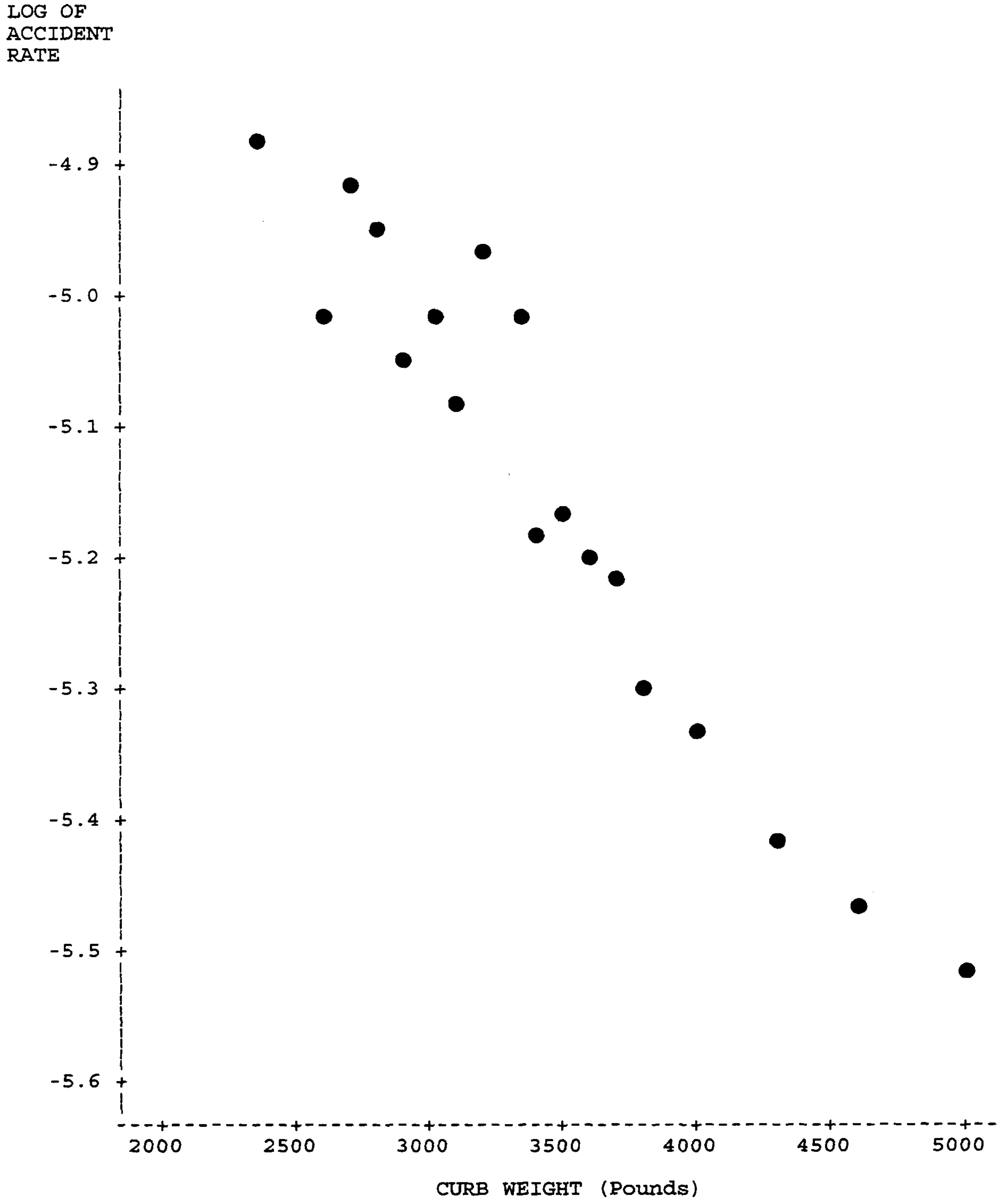


FIGURE 4-5

LIGHT TRUCKS: INDUCED-EXPOSURE CRASHES,
PER 1000 VEHICLE REGISTRATION YEARS, BY CURB WEIGHT
(excluding vans weighing over 4000 pounds)



4.4 Regression analyses

The next task is to perform regression analyses on the induced-exposure accident rates, per 1000 vehicle years, by curb weight, driver age, sex and other variables. Disaggregate logistic regression as in Chapter 3, but with individual vehicle registration years as "successes" and induced-exposure involvements as "failures," is impossible because driver age and sex is not defined for individual vehicle years. In fact, the only information on age and sex is in the accident data. One feasible approach is to **aggregate** the registration and accident data into **cells** - e.g. by make-model and model year. These cells will supply the data points for the regression. For each cell (e.g., make-model-model year), the number of crashes is divided by the sum of the registrations to obtain an accident rate: the dependent variable. The average age of the drivers in the **induced-exposure involvements** is found for each cell; also the percentage of the crash-involved drivers in the cell who are female, the percent of involvements occurring at night, etc. Thus, many independent variables for the regressions can be defined, as cell averages, from the accident data. An **aggregate linear regression** is performed on the accident rates and independent variables defined in the various cells.

One problem with aggregate regressions is that when there are many independent variables, the data get split up into many cells, according to the values of those variables. Before long, the cells are too small: they have so few accidents in them that the accident rates are not meaningful. One way to abate the glut of cells is to perform the analysis in two steps. In Step 1, a regression of the accident rates is performed on some of the control variables (a short enough list of variables to allow cells of reasonable size), and regression coefficients are obtained for those variables. The original induced-exposure involvements are weighted upward or downward, based on the coefficients. In Step 2, a regression of the adjusted accident rates (obtained by using the weighted induced-exposure involvements) is performed on curb weight and the control variables not used in Step 1. The cells in Step 2 will also be of adequate size, since they will not be subcells of the Step 1 cells.

Table 4-1 documents the Step 1 regression for **passenger cars**. The independent variables describe the vehicle's age, the State, and the calendar year, and they are defined exactly as in Section 3.1. These variables are actually definable on the Polk data as well as on the accident data. The procedure is to split the Polk and accident data into cells by State, calendar year and model year (total of 318 cells). (In each cell, VEHAGE = CY - MY.) The accident rate is computed in each cell and its **logarithm** is the dependent variable. The logarithm is taken because it tends to have more nearly linear relationships with typical independent variables than does the accident rate itself: Figure 4-5 is a fine example. Since some cells are more important than others, because they contain more data, the regression is **weighted** by REGS, the number of vehicle registration years in a cell. Weighted linear regression is performed by the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) [30]. R^2 for this regression was a very high .96. R^2 is not a particularly meaningful measure of fit in regressions with aggregate data, since it is highly sensitive to the level of aggregation of the data, but .96 is gratifying under almost any circumstances.

The lower section of Table 4-1 shows that the Step 1 control variables generally have plausible, statistically significant relationships with the induced-exposure accident rate. For example,

TABLE 4-1

PASSENGER CARS: AGGREGATE LINEAR REGRESSION
OF INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE REGISTRATION YEARS

STEP 1: BY VEHICLE AGE, STATE AND CALENDAR YEAR

Dependent Variable: LOGRATE (logarithm of the accident rate)

Aggregation Method: by State, Calendar Year and Model Year

N of Observations: 318

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-5.153842451	-297.26	0.0001	0.01733811
VEHAGE	-0.036073663	-12.45	0.0001	0.00289645
BRANDNEW	-0.071165805	-3.73	0.0002	0.01909006
ILLINOIS	0.659493011	39.37	0.0001	0.01675182
LOUISIAN	0.487165826	9.15	0.0001	0.05324586
MARYLAND	-0.366837279	-16.84	0.0001	0.02177872
MICHIGAN	0.646112793	32.04	0.0001	0.02016577
MISSOURI	0.105245041	5.05	0.0001	0.02083990
NEWMEXIC	0.206270737	4.66	0.0001	0.04425203
NORTHCAR	-0.015989270	-0.63	0.5311	0.02549925
OHIO	0.439142151	24.60	0.0001	0.01785291
PENNA	-0.434911963	-28.65	0.0001	0.01518201
UTAH	-0.249006474	-6.77	0.0001	0.03678406
CY89	0.149064930	8.96	0.0001	0.01663988
CY90	0.063316951	4.02	0.0001	0.01574288
CY92	0.051233250	3.49	0.0006	0.01467291
CY93	0.064640644	3.97	0.0001	0.01627533

VEHAGE (vehicle age) has a coefficient of -.036. The t-value for that coefficient is -12.45, which is certainly significant (approximately 1.96 is needed for significance at the two-sided .05 level, 2.58 at the .01 level). In other words, the induced-exposure accident rate decreases by 3.6 percent a year as a car gets older - similar to reductions in annual mileage as cars age [13], p. 3-43. The negative coefficient for BRANDNEW is surprising at first glance, because cars tend to be driven a lot in their first year. However, many vehicles of the latest model year listed on the Polk file (which is compiled as of July 1) are on the road for less than a full calendar year, and do not pick up a full year's worth of induced exposure.

States with low accident-reporting thresholds and/or high traffic densities, such as Illinois, Michigan and Ohio have higher rates of induced-exposure crashes per 1000 vehicle years than Florida, the "baseline" State; Maryland and Pennsylvania, with high reporting thresholds, have low rates. Calendar year 1989 had higher accident rates than all subsequent years, including 1991, the "baseline" year.

In preparation for the Step 2 regression, each induced-exposure crash involvement is given a weight factor corresponding to the inverse of the Step 1 regression coefficients. For example, consider a 2-year-old [model year 1987] car, struck while standing still, in Illinois, in calendar year 1989. Since the coefficients for VEHAGE, ILLINOIS and CY89 are -.036, .659 and .149 respectively, this crash will not be counted as 1 crash in Step 2, but will count as

$$\exp(2 \times .036 - .659 - .149) = .479 \text{ crashes}$$

In other words, since induced-exposure involvements are more common in Illinois and in 1989 than in other places and times, these crashes are weighted downwards to equalize accident rates across States, calendar years and vehicle age.

In the Step 2 regression, the Polk data and the accident data (with their weight factors) are split into cells by car group (CG), make-model (MM2), body style (BOD2) and model year (MY). A modest number of low-volume combinations (fewer than 2000 cumulative vehicle years) are excluded, because the accident rates for those combinations might be zero or unrealistically high. That leaves 1879 data points for the regression. For each data point (CG-MM2-BOD2-MY combination), the **weighted** count of induced-exposure crashes (i.e., the sum of the weight factors defined above) is divided by the sum of the vehicle years to define the adjusted accident rate. The dependent variable is the logarithm of that rate. The key independent variable, curb weight, is listed by CG, MM2, BOD2 and MY in a look-up table (Appendix D). The control variables CONVRTBL, TWODOOR and STAWAGON may be defined directly from BOD2, as in Section 3.1, and will have the value 0 or 1, as in Section 3.1. The other control variables (YOUNGDRV, OLDMAN, OLDWOMAN, FEMALE, NITE, SPDLIM55, RURAL, WET, SNOW_ICE) are the weighted averages for these variables among the induced-exposure crashes in the cell (and for SPDLIM55 and RURAL, the Michigan cases are not used in computing the average, since the variables were always set to zero, there). As in Step 1, the regression is **weighted** by REGS, the number of vehicle registration years in a cell.

Table 4-2 documents the Step 2 regression for **passenger cars**. R^2 was a very satisfactory .56. The most important finding is that curb weight has a coefficient of -.000027. In other words,

TABLE 4-2

PASSENGER CARS: AGGREGATE LINEAR REGRESSION OF INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE REGISTRATION YEARS

STEP 2: BY **CURB WEIGHT**, CONTROLLING FOR DRIVER AGE, SEX AND OTHER VEHICLE AND ACCIDENT FACTORS

Dependent Variable: LOGRATE (logarithm of the accident rate, calculated after adjusting the induced exposure by vehicle age, State, and CY, based on the coefficients from the Step 1 regression)

Aggregation Method: by Car Group, Make-Model, Body Style and Model Year

N of Observations: 1879 (observations with fewer than 2000 vehicle registration years were deleted)

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-5.121235342	-69.01	0.0001	0.07421046
CURBWT	**-0.000026602**	**-2.26**	**0.0241**	**0.00001178**
YOUNGDRV	0.027826728	7.18	0.0001	0.00387582
OLDMAN	-0.037386348	-7.21	0.0001	0.00518451
OLDWOMAN	-0.039741946	-5.94	0.0001	0.00668630
FEMALE	0.030050655	0.50	0.6157	0.05985753
NITE	0.595671777	5.17	0.0001	0.11517003
SPDLIM55	0.167986500	1.00	0.3151	0.16718441
RURAL	-0.251967958	-2.31	0.0211	0.10913593
CONVRTBL	-0.300385085	-9.58	0.0001	0.03136161
TWODOOR	-0.088259226	-8.34	0.0001	0.01058197
STAWAGON	-0.048653406	-2.99	0.0028	0.01626529
WET	-0.046446081	-0.40	0.6888	0.11596491
SNOW_ICE	-0.140287901	-0.46	0.6440	0.30355771

after controlling for driver age, sex, etc., the induced-exposure accident rate per 1000 vehicle years decreases by 0.27 percent for every 100 pound increase in curb weight. Although that bias is statistically significant (t for the coefficient is -2.26, $p < .05$), it is essentially nil, in practical terms. The regression analyses in Table 3-2 showed effects of curb weight ranging from -1.00 to +3.17 percent fatality changes per 100 pound reduction in weight. Compared to those effects, a bias of 0.27 percent per 100 pounds is well within sampling error.

The effects of the control variables YOUNGDRV, OLDMAN and OLDWOMAN, are statistically significant, and they appear to have the right direction and magnitude. They are the most important control variables, since driver age is highly correlated with curb weight. The coefficient for YOUNGDRV is +.028 - i.e., the number of induced-exposure crashes per 1000 years increases by 2.8 percent for every year that the driver is under 35. That makes sense because younger drivers (except for age 16-17) tend to drive more miles than 35-50 year-olds. The coefficients for OLDMAN and OLDWOMAN are -.037 and -.040, reflecting the fact that people drive a bit less every year, once they pass age 45-50.

The coefficient for FEMALE is a nonsignificant +.03. Although women drive less than men, that is offset because their less aggressive driving makes them more prone to being hit while standing still. The coefficient of +.60 for NITE requires careful interpretation. It does not imply that induced-exposure crashes are more common at night (in fact, they are less common). In this regression, NITE is not entered for individual crashes, but as an **average** for all crashes involving a particular make-model. The coefficient signifies that make-models that tend to get driven a lot at night, such as Chevrolet Camaro, tend to be driven more, overall, and have more induced-exposure crashes [during the daytime as well as at night] than vehicles that are driven relatively more during the day, such as Mercury Grand Marquis. Similar interpretations apply to the coefficients for SPDLIM55, RURAL, WET and SNOW_ICE. The negative coefficients for CONVRTBL and TWODOOR may reflect that these vehicles tend to have more aggressive drivers than average, who are less frequently struck while standing still, because they are the first to move at a green light or four-way stop.

The Step 2 regression in Table 4-3 is the same as in Table 4-2, except that the nonsignificant variables SPDLIM55, WET and SNOW_ICE have been deleted. (Although FEMALE, itself, has a nonsignificant effect, the variable is retained because it had been used in the definition of another, significant variable: OLDWOMAN.) The removal of those three control variables hardly changes the coefficients for the remaining variables, and the net bias for curb weight remains about the same: 0.24 percent per 100 pounds.

Table 4-4 presents the Step 1 regression for **light trucks**. The procedure is the same as for cars. Polk and accident data for light trucks are celled by State, calendar year and model year. The accident rate is computed in each cell and its logarithm is the dependent variable. R^2 was .94. The coefficients for the States and calendar years were essentially the same as for passenger cars (Table 4-1). The only noteworthy difference is that the coefficient for VEHAGE is about twice as large for light trucks (-.071 vs. -.036), perhaps reflecting a stronger drop-off in annual mileage, as the vehicles get older. In preparation for Step 2 regressions, each induced-exposure crash involvement is given a weight factor corresponding to the inverse of the Table 4-4 regression coefficients.

TABLE 4-3

PASSENGER CARS: AGGREGATE LINEAR REGRESSION
OF INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE REGISTRATION YEARS

STEP 2: BY **CURB WEIGHT**, CONTROLLING FOR DRIVER AGE, SEX
AND OTHER VEHICLE AND ACCIDENT FACTORS

(without SPDLIM55, WET and SNOW_ICE)

Dependent Variable: LOGRATE (logarithm of the accident rate, calculated after adjusting the induced exposure by vehicle age, State, and CY, based on the coefficients from the Step 1 regression)

Aggregation Method: by Car Group, Make-Model, Body Style and Model Year

N of Observations: 1879 (observations with fewer than 2000 vehicle registration years were deleted)

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-5.099218633	-79.26	0.0001	0.06433641
CURBWT	**-0.000024121**	**-2.06**	**0.0398**	**0.00001172**
YOUNGDRV	0.028547980	7.42	0.0001	0.00384869
OLDMAN	-0.037090081	-7.19	0.0001	0.00515665
OLDWOMAN	-0.039855825	-6.10	0.0001	0.00653419
FEMALE	0.021576640	0.36	0.7162	0.05933163
NITE	0.569398829	4.99	0.0001	0.11419124
RURAL	-0.347145235	-3.49	0.0005	0.09945196
CONVRTBL	-0.299597636	-9.67	0.0001	0.03098399
TWODOOR	-0.087550413	-8.32	0.0001	0.01052117
STAWAGON	-0.048886883	-3.09	0.0020	0.01583432

TABLE 4-4

LIGHT TRUCKS: AGGREGATE LINEAR REGRESSION
OF INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE REGISTRATION YEARS

STEP 1: BY VEHICLE AGE, STATE AND CALENDAR YEAR

Dependent Variable: LOGRATE (logarithm of the accident rate)

Aggregation Method: by State, Calendar Year and Model Year

N of Observations: 308

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-5.135145823	-229.53	0.0001	0.02237269
VEHAGE	-0.071002394	-19.15	0.0001	0.00370698
BRANDNEW	-0.068148093	-2.90	0.0041	0.02353434
ILLINOIS	0.552444543	24.26	0.0001	0.02277264
LOUISIAN	0.545650039	9.66	0.0001	0.05651272
MARYLAND	-0.511622507	-17.57	0.0001	0.02911427
MICHIGAN	0.619181498	24.35	0.0001	0.02542730
MISSOURI	-0.039230761	-1.59	0.1124	0.02463774
NEWMEXIC	0.189248875	4.65	0.0001	0.04069563
NORTHCAR	-0.227740166	-7.61	0.0001	0.02991433
OHIO	0.396693700	17.11	0.0001	0.02318610
PENNA	-0.497626454	-24.57	0.0001	0.02025236
UTAH	-0.280789332	-7.32	0.0001	0.03837666
CY89	0.136715816	6.32	0.0001	0.02161886
CY90	0.065478752	3.23	0.0014	0.02024295
CY92	0.057591792	3.06	0.0024	0.01879016
CY93	0.111960865	5.44	0.0001	0.02059889

Table 4-5 documents a Step 2 regression for light trucks (excluding, as stated above, any vans weighing over 4000 pounds). The method is similar, but not identical to the one for passenger cars. Polk and accident data are split into cells by light truck group (CG), make-model (MM2) and model year (MY). After combinations with fewer than 2000 cumulative vehicle years are excluded, there are 1036 data points. Instead of the control variables CONVRTBL, TWODOOR and STAWAGON, there are variables for the type of truck, SUV and VAN (a pickup truck being the "baseline" type), plus AWD to indicate if the truck had four-wheel drive. An initial regression produced nonsignificant coefficients for SPDLIM55, WET and SNOW_ICE, as with passenger cars, and these were eliminated from the Table 4-5 regression, which had $R^2 = .56$.

Curb weight had a coefficient of -.00025, about ten times as large as for passenger cars, and highly significant ($t = -16.99$, $p < .01$). In other words, the induced-exposure accident rate per 1000 years, for light trucks, drops off by 2.5 percent for every 100 pounds of weight increase, even after controlling for driver age and sex. As suspected, the results for light trucks in Chapter 3 are strongly biased.

The coefficients for YOUNGDRV, OLDMAN and OLDWOMAN have the same direction as for passenger cars, but the YOUNGDRV coefficient is weaker than for cars (+.008 vs. +.028) while the coefficients for OLDMAN and OLDWOMAN are more strongly negative (-.074 and -.093 for trucks vs. -.037 and -.040 for cars). These results are consistent with the intuition that older drivers, especially women, do not accumulate large mileage in trucks.

It is interesting to compare the Chapter 3 results for cars and light trucks after they have been "corrected" for the biases found in the preceding analyses (i.e., 0.27 percent per 100 pounds for cars, and 2.50 percent for trucks):

	Effect on Fatalities per 100 Pound Reduction (%)			
	Uncorrected		Corrected for Bias	
	Cars	Trucks	Cars	Trucks
Principal rollover	+2.48	- .80	+2.75	+1.70
Hit object	+1.91	-1.30	+2.18	+1.20
Ped-bike-motorcycle	-1.00	-4.40	- .73	-1.90
Hit big truck	+2.62	+ .49	+2.89	+2.99
Hit passenger car	+ .78	-3.40	+1.05	- .90
Hit light truck	+3.17	-3.30	+3.44	- .80

The corrected estimates make more sense than the uncorrected numbers. In the first four types of crashes, which involve only one car or light truck per crash, the corrected effects of cars and light trucks are in the same direction: positive in rollovers and collisions with fixed objects or big trucks, negative in collisions with pedestrians. But in three cases, the effect for cars is more

TABLE 4-5

LIGHT TRUCKS: AGGREGATE LINEAR REGRESSION
OF INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE REGISTRATION YEARS
(excluding vans weighing over 4000 pounds)

STEP 2: BY **CURB WEIGHT**, CONTROLLING FOR DRIVER AGE, SEX
AND OTHER VEHICLE AND ACCIDENT FACTORS

Dependent Variable:	LOGRATE (logarithm of the accident rate, calculated after adjusting the induced exposure by vehicle age, State, and CY, based on the coefficients from the Step 1 regression)
Aggregation Method:	by Light Truck Group, Make-Model and Model Year
N of Observations:	1036 (observations with fewer than 2000 vehicle registration years were deleted)
Weighting Factor:	REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-4.092850929	-47.00	0.0001	0.08708228
CURBWT	**-0.000250108**	**-16.99**	**0.0001**	**0.00001472**
YOUNGDRV	0.008157641	1.34	0.1809	0.00609250
OLDMAN	-0.074261537	-7.17	0.0001	0.01035830
OLDWOMAN	-0.093494250	-4.01	0.0001	0.02331047
FEMALE	0.145142814	2.30	0.0217	0.06312791
NITE	-0.405703128	-2.97	0.0030	0.13650050
RURAL	-0.414512865	-3.89	0.0001	0.10656685
SUV	0.099642394	5.54	0.0001	0.01800210
VAN	-0.028053882	-1.60	0.1102	0.01754872
AWD	-0.032083890	-2.10	0.0361	0.01528525

positive (or less negative) than for light trucks. In car-to-car and truck-to-truck collisions, the weight-safety effect is relatively small. In car-to-light truck collisions, a reduction in car weight increases the overall fatalities (most of whom are occupants of the cars), while an reduction in truck weight reduces the fatalities.

4.5 Comparison with National Personal Transportation Survey data

The preceding analyses accurately estimate the relationship between curb weight and the induced-exposure accident rate only if they accurately adjust for the effects of driver age. Two factors diminish confidence that the regression analyses correctly gauge the effects of age: (1) Only the accident cases (not the registration data) have information on driver age. The values of YOUNGDRV, etc. that are used in the regression are make-model-MY averages for the accident data. That is not the usual way to define independent variables in a regression. (2) Whereas driver age and curb weight for **individual** accident cases have a "safe" level of intercorrelation (e.g., YOUNGDRV and CURBWT have a correlation coefficient of -.26 for cars and -.18 for trucks), the correlation coefficient is much higher when the cases are **aggregated** at the make-model-MY level. At that level of aggregation, the cell-average values of YOUNGDRV and CURBWT have correlation coefficients -.66 for cars and -.53 for light trucks. In other words, some big cars have young drivers and some small cars have old drivers, but, on the average, bigger cars have older drivers. While .66 and .53 are not high enough levels of intercorrelation to guarantee bad regressions (like analysis C4 in Table 3-2, where the intercorrelation was .89), they are no longer "safe" levels. The coefficients for driver age in Tables 4-2, 4-3 and 4-5 seemed plausible, but "looking right" is not enough to assure validity. It would be better to provide additional data that confirms the observed effects for age.

The National Personal Transportation Survey of 1990 (NPTS) [13] includes two tables that classify "exposure" in the United States by driver age. On p. 3-48, 130 million cars and light trucks are classified by the "principal driver's age." Although these data do not correspond exactly to vehicle years, and many vehicles are omitted, and they apply to the entire United States for 1990, not 11 States for 1989-93, it is possible to get a general idea of the driver-age effect by computing the ratios of induced-exposure crashes (based on the combined car and light truck accident files) per 1000 vehicles, by age group:

Vehicles - All Cars and Light Trucks

Principal Driver's Age	Vehicles (000)	Induced Exposure Crashes	Ratio Crashes to Veh.	Log Ratio	Δ Age	Effect Per Year
16-19	4,884	50,242	10.29	2.53	17	+.031
20-29	25,700	201,296	7.83	2.06	10	+.026
30-39	32,489	198,463	6.11	1.81	-	
40-49	24,578	145,559	5.92	1.78	-	
50-59	16,618	78,095	4.70	1.55	6	-.042
60-64	7,160	28,493	3.98	1.38	14	-.030
65+	16,969	46,392	2.73	1.00	23	-.035

For example, there were 4,884,000 vehicles in the United States whose "principal driver" was 16-19 years old. There were 50,242 induced-exposure crashes in the 11-State accident files involving drivers aged 16-19. That is a ratio of 10.29 crashes per 1000 vehicles, and its logarithm is 2.53. The ratio of crashes to vehicles drops from 10.29 at age 16-19 to 6.11 at age 30-39. It remains stable near 6 from age 30 to 49. Then it continues to drop, and reaches 2.73 for drivers over 65. Similarly, the logarithm of the ratio is stable at 1.80 for drivers aged 30-49, higher for young drivers, lower for old drivers. The average teen-aged driver is about 18, and will have YOUNGDRV = 17 (i.e., be 17 years younger than the "middle age range," which is 35-50 for males and 35-45 for females). Since the logarithm of the crashes-to-vehicles ratio drops from 2.53 to 1.80 in 17 years, the average effect per year for YOUNGDRV is +.031. Similarly, the 20-29 age group suggests an effect for YOUNGDRV of +.026 per year.

The log ratio of crashes to vehicles was 1.55 for drivers age 50-59, which is .25 below the 1.80 for 30-49 year-old drivers. The average value of OLDMAN (years over 50) is 4 for 50-59 year-old male drivers, and the average value of OLDWOMAN (years over 45) is 9 for 50-59 year-old female drivers; thus, the average for both of these is 6, and the effect of driver age, for older drivers is -.25/6 = -.042 per year. Similarly, the 60-64 and 65+ age groups suggest effects of -.030 and -.035. In other words, the NPTS data suggest effects of about +.03 for YOUNGDRV and about -.035 for OLDMAN and OLDWOMAN. Those are remarkably close to the coefficients in the regression for passenger cars (Table 4-2), which constitute the majority of all vehicles: +.028 for YOUNGDRV, -.037 for OLDMAN and -.040 for OLDWOMAN.

NPTS also provides (p. 3-11) the age distribution of licensed drivers in the United States in 1990. Induced-exposure crashes per 1000 drivers could be a surrogate for crashes per 1000 vehicle years:

Licensed Drivers - All Cars and Light Trucks

Driver Age	Drivers (000)	Induced Exposure Crashes	Ratio Crashes to Drv.	Log Ratio	Δ Age	Effect Per Year
16-19	9,546	50,242	5.26	1.66	17	+.002
20-29	34,847	201,296	5.77	1.75	10	+.013
30-39	38,791	198,463	5.11	1.63	-	
40-49	29,134	145,559	5.00	1.61	-	
50-59	19,742	78,095	3.96	1.38	6	-.040
60-64	8,877	28,493	3.21	1.17	14	-.032
65+	20,281	46,392	2.29	.83	23	-.034

In general, there are more young drivers than there are vehicles whose "principal driver" is young, while the two numbers are more nearly equal in the higher age groups. This table shows an effect for YOUNGDRV of about .01 per year, which is lower than what was found in the regressions for cars, but about the same as what was found for light trucks (.008 in Table 4-5). The effect for older drivers is again close to -.035.

The NPTS table on p. 3-48, classifying vehicles by their "principal driver's" age, also subdivides the vehicles into three types: autos and vans, pickups, other privately owned vehicles. Their definitions are not necessarily the same as in this report (specifically, their "vans" only include passenger vehicles, not cargo vans and small recreational vehicles). It seems most appropriate to let their "autos and vans" correspond to "passenger cars" in this report (since "vans," however defined, are only a small percentage of "autos and vans"), and their "pickups" and "other privately owned vehicles" (combined) correspond to pickup trucks and SUVs (combined) in this report. The ratios of induced-exposure crashes per 1000 passenger cars are as follows:

Vehicles - Passenger Cars

Principal Driver's Age	Vehicles (000)	Induced Exposure Crashes	Ratio Crashes to Veh.	Log Ratio	Δ Age	Effect Per Year
16-19	4,266	39,682	9.30	2.23	17	+.032
20-29	21,160	155,052	7.33	1.99	10	+.031
30-39	25,691	138,489	5.39	1.68	-	
40-49	19,290	104,949	5.44	1.69	-	
50-59	12,690	58,884	4.64	1.53	6	-.027
60-64	5,639	22,614	4.01	1.39	14	-.021
65+	14,040	40,216	2.86	1.05	23	-.028

The effect for YOUNGDRV is about +.032, which is nearly the same as was obtained in the regression analysis (+.028). The effect for older drivers, approximately -.025, is slightly weaker than the values in the regression (-.037, -.039).

The ratios of induced-exposure crashes per 1000 pickup trucks and SUVs are as follows:

Vehicles - Pickup Trucks and SUVs

Principal Driver's Age	Vehicles (000)	Induced Exposure Crashes	Ratio Crashes to Veh.	Log Ratio	Δ Age	Effect Per Year
16-19	613	8,879	14.48	2.67	17	+.062
20-29	4,535	37,629	8.30	2.11	10	+.050
30-39	6,798	37,104	5.46	1.70	-	
40-49	5,280	24,165	4.58	1.52	-	
50-59	3,928	12,740	3.24	1.18	6	-.072
60-64	1,521	3,740	2.46	.90	14	-.051
65+	2,929	3,768	1.29	.25	23	-.059

In general, the accident rates for light trucks show a stronger drop-off with increasing driver age than the rates for passenger cars. That produces stronger effects for both young and old drivers. The effect for YOUNGDRV averages to about +.055, which is substantially stronger than in the regression analysis (+.008). The effect for older drivers averages to -.060, and it is slightly weaker than the values in the regression (-.074, -.093). In other words, these data are at odds with the regression in that they show a strong young-driver effect, but they confirm the strong old-driver effect in the regression.

NPTS does not subdivide its table of licensed drivers by vehicle type, but an *ad hoc* subdivision may be obtained by apportioning the licensed drivers among "autos" and "pickups and SUVs" by the same ratios as in the two preceding tables. For example, since there are 9,546,000 licensed drivers age 16-19, and they primarily drive 4,266,000 autos and vans and 613,000 pickups and SUVs, apportion 8,343,000 of the drivers to autos and 1,203,000 to pickups and SUVs. For passenger cars, the ratio of induced-exposure crashes per 1000 licensed drivers are as follows:

Licensed Drivers - Passenger Cars

Driver Age	Drivers (000)	Induced Exposure Crashes	Ratio Crashes to Drv.	Log Ratio	Δ Age	Effect Per Year
16-19	8,343	39,682	4.76	1.56	17	+.003
20-29	28,679	155,052	5.41	1.69	10	+.018
30-39	30,684	138,489	4.51	1.51	-	
40-49	22,870	104,949	4.59	1.52	-	
50-59	15,083	58,884	3.90	1.36	6	-.027
60-64	5,995	22,614	3.23	1.17	14	-.025
65+	16,772	40,216	2.40	.88	23	-.028

The average effects of approximately .015 for young drivers and -.027 for older drivers are both slightly weaker than in the regression analysis.

For pickup trucks and SUVs, the ratio of induced-exposure crashes per 1000 licensed drivers are as follows:

Licensed Drivers - Pickup Trucks and SUVs

Driver Age	Drivers (000)	Induced Exposure Crashes	Ratio Crashes to Drv.	Log Ratio	Δ Age	Effect Per Year
16-19	1,203	8,879	7.38	2.00	17	+.033
20-29	6,168	37,629	6.10	1.81	10	+.038
30-39	8,107	37,104	4.58	1.52	-	
40-49	6,264	24,165	3.86	1.35	-	
50-59	4,659	12,740	2.73	1.01	6	-.071
60-64	1,882	3,740	1.99	.69	14	-.098
65+	3,509	3,768	1.08	.07	23	-.059

These data are fairly consistent with the regression analysis for light trucks, exhibiting a relatively weak positive effect (averaging +.035) for younger drivers and a strongly negative effect (averaging -.075) for older drivers.

The NPTS data do not duplicate the age coefficients found in the regression analyses, but that could hardly be expected given the differences in the definitions of "exposure," the definitions of the vehicles, the States included (all 50 vs. 11) and the years of the data (1990 vs. 1989-93).

Nevertheless, the coefficients are in the same direction and order of magnitude, and in some cases come very close to matching the regressions. As a whole, the NPTS data are strong evidence that the regression analyses correctly modeled the effects of driver age.

4.6 Sensitivity tests

There is an additional method to gauge the accuracy of the curb-weight coefficients in the regression analyses, given the uncertainty about the adjustments for driver age: measure the sensitivity of the curb-weight coefficients to changes in the coefficients for the driver-age variables YOUNGDRV, OLDMAN and OLDWOMAN. If it were possible to "force" different driver-age coefficients into the regression, such as the coefficients seen in the analyses of NPTS data, what would that do to the CURBWT coefficient?

The same procedure that was used in Section 4.4 to perform the regression analysis in two steps, and to adjust the induced-exposure data based on the coefficients for State, vehicle age and CY obtained in the Step 1 regression, can also be used to "force" any desired combination of coefficients for YOUNGDRV, OLDMAN and OLDWOMAN into the analysis. The induced-exposure crash involvements are simply given weight factors corresponding to the inverse of the desired coefficients. For example, suppose there are 1000 induced-exposure crashes of 1986 Camaros (after the Step 1 adjustments) and their 1000 drivers have average values of 8.5 for YOUNGDRV, 1.0 for OLDMAN and 0.5 for OLDWOMAN. Suppose that the desired coefficients are +.030 for YOUNGDRV, -.035 for OLDMAN and -.035 for OLDWOMAN. These 1000 crashes will only be counted as

$$1000 \times \exp(-.030 \times 8.5 + .035 \times 1.0 + .035 \times 0.5) = 817 \text{ crashes}$$

and the regression, with the adjusted induced-exposure data, will be performed with the independent variables CURBWT, FEMALE, NITE, RURAL, CONVRTBL, TWODOOR and STAWAGON, but **not** YOUNGDRV, OLDMAN or OLDWOMAN. For light trucks, SUV, VAN and AWD are used instead of CONVRTBL, TWODOOR and STAWAGON.

Table 4-6 shows the results of the sensitivity tests for **passenger cars**. First, the two baseline regressions, in which the coefficients for the driver-age variables were not "forced," but were calibrated by the regression itself, have already been documented in Tables 4-2 and 4-3. As discussed in Section 4.4, these regressions produced negligible coefficients of -.000027 and -.000024, respectively, for CURBWT. Inclusion or exclusion of the nonsignificant control variables SPDLIM55, WET and SNOW_ICE makes little difference. Next (not shown in Table 4-6), the validity of the "forced-coefficient" method was tested by adjusting the induced-exposure crashes based on the driver-age coefficients (+.029, -.037, -.040) for the baseline regression without SPDLIM55, WET and SNOW_ICE, and running the regression without the driver-age variables. This worked just like the original baseline regression, producing the identical -.000024 coefficient for CURBWT, and also identical coefficients for the remaining control variables.

The first four sensitivity tests use the driver-age coefficients suggested by four NPTS analyses.

TABLE 4-6

PASSENGER CARS: SENSITIVITY OF THE CURB WEIGHT COEFFICIENT TO CHANGES IN THE DRIVER AGE COEFFICIENTS

(regressions of induced-exposure crashes per 1000 vehicle years)

	Regression Cofficients			
Source/Explanation of Driver Age Coefficients	**YOUNGDRV**	**OLDMAN**	**OLDWOMAN**	**CURBWT**
Baseline (with SPDLIM55, WET, SNOW_ICE)	+.028	-.037	-.039	**-.000027**
Baseline (w/o SPDLIM55, WET, SNOW_ICE)	+.029	-.037	-.040	**-.000024**
NPTS, per 1000 vehicles, all types of vehicles	+.030	-.035	-.035	**-.000027**
NPTS, per 1000 drivers, all types of vehicles	+.010	-.035	-.035	**-.000066**
NPTS, per 1000 vehicles, cars only	+.032	-.025	-.025	**-.000039**
NPTS, per 1000 drivers, cars only	+.015	-.027	-.027	**-.000069**
Baseline strengthened by .02	+.048	-.057	-.059	**-.000097**
Baseline weakened by .02	+.008	-.017	-.019	**+.000048**
Driver age in 5-year cohorts				**-.000009**

For example, the first NPTS analysis of the ratio of induced-exposure crashes per 1000 vehicles in which the age of the "principal" driver was known, combining the data for cars and light trucks, suggested effects of +.030 per year for younger drivers and -.035 per year for older drivers. When these driver age coefficients are entered into the analysis, the resulting coefficient for curb weight, -.000027 remains nearly identical to the baseline. The other three NPTS analyses (per 1000 licensed drivers - all vehicle types, per 1000 vehicles - cars only, per 1000 licensed drivers - cars only) produced CURBWT coefficients ranging from -.000039 to -.000069, all fairly close to the baseline value.

Two additional sensitivity tests consider the effect of an absolute change of .02 from the baseline for all three variables. When each driver-age coefficient is strengthened by .02, the CURBWT effect escalates to -.000097. If each coefficient is weakened by .02, the CURBWT effect crosses over to +.000048. These two values represent a sort of outer range for the possible curb weight effect.

The last sensitivity test does not use "forced" driver-age coefficients. Instead, the original Step 2 regression is run, but with YOUNGDRV, OLDMAN, and OLDWOMAN replaced by a large set of variables corresponding to 5-year-cohorts of driver age. For example, M22 is the proportion of the drivers in the induced-exposure crashes (of a particular make-model-MY) who are male and 20-24 years old; F68 is the proportion who are female and 66-70 years old, etc. The objective of this approach is to break up some of the correlation between curb weight and the driver-age variables, reducing the danger of intercorrelation problems. It produced a coefficient of -.000009 for curb weight, quite close to the baseline value.

The sensitivity tests for passenger cars support the earlier conclusion that the effect of curb weight on induced-exposure crashes per 1000 vehicle years is negligible.

Table 4-7 documents the sensitivity tests for **light trucks**. The second test is the baseline regression without SPDLIM55, WET or SNOW_ICE, already documented in Table 4-5, which produced a coefficient of -.000250 for CURBWT (ten times as strong an effect as for passenger cars). The addition of the nonsignificant variables SPDLIM55, WET and SNOW_ICE, barely affects the result, reducing it to -.000246. The four sensitivity tests based on driver-age coefficients suggested by the NPTS analyses (for all vehicles, or for pickups and SUVs only) produced CURBWT coefficients ranging from -.000168 to -.000263. Strengthening or weakening the driver-age coefficients by .02 produced a CURBWT coefficients ranging from -.000205 to -.000296. Finally, replacing the original driver-age variables with the 5-year cohorts resulted in a CURBWT coefficient of -.000246, nearly identical to the baseline.

In all the sensitivity tests for light trucks, the CURBWT coefficients ranged from -.000168 to -.000296. The least negative coefficient produced for light trucks is substantially stronger than the most negative one for passenger cars. These tests support the earlier conclusion that induced-exposure crashes per 1000 vehicle years decrease by slightly more than 2 percent for every 100-pound increase in the weight of light trucks. Possible explanations for the bias have been discussed in Sections 1.4 and 3.5: owners of the larger light trucks may not be obliged to report, or may choose not to report, vehicle damages in minor impacts when they were standing still prior to the crash (induced-exposure impacts).

TABLE 4-7

LIGHT TRUCKS: SENSITIVITY OF THE CURB WEIGHT COEFFICIENT TO CHANGES IN THE DRIVER AGE COEFFICIENTS

(regressions of induced-exposure crashes per 1000 vehicle years)

	Regression Cofficients			
Source/Explanation of Driver Age Coefficients	**YOUNGDRV**	**OLDMAN**	**OLDWOMAN**	**CURBWT**
Baseline (with SPDLIM55, WET, SNOW_ICE)	+.007	-.073	-.095	**-.000246**
Baseline (w/o SPDLIM55, WET, SNOW_ICE)	+.008	-.074	-.093	**-.000250**
NPTS, per 1000 vehicles, all types of vehicles	+.030	-.035	-.035	**-.000225**
NPTS, per 1000 drivers, all types of vehicles	+.010	-.035	-.035	**-.000263**
NPTS, per 1000 vehicles, pickups and SUVs only	+.055	-.060	-.060	**-.000168**
NPTS, per 1000 drivers, pickups and SUVs only	+.035	-.075	-.075	**-.000200**
Baseline strengthened by .02	+.028	-.094	-.113	**-.000205**
Baseline weakened by .02	-.012	-.054	-.073	**-.000296**
Driver age in 5-year cohorts				**-.000246**

CHAPTER 5

FATALITIES PER MILLION VEHICLE YEARS IN THE UNITED STATES ANALYSIS METHODS

5.1 Analysis objective

It would be gratifying to base the size-safety analysis on fatality rates per million vehicle registration years. A vehicle year is a clearly defined, widely accepted unit of exposure. R. L. Polk's *National Vehicle Population Profile* [26] gives precise, complete counts of actual vehicle years. There is no issue of reporting biases, as there was with induced-exposure crashes: there is essentially no such thing as an unreported vehicle year. Moreover, Polk reported or estimated vehicle registrations for every State during 1989-93. The analyses of induced-exposure crashes had to be limited to the 11 State accident files containing VIN information. Analyses of fatality rates per million vehicle years could be performed on data from the entire United States, greatly increasing the fatality sample size.

The problem with analyses of fatality rates per million vehicle years was that registration data have no information on the age and sex of the drivers, or other control variables that would be needed for a meaningful analysis of fatality risk by vehicle weight. The solution is that the induced-exposure accident data analyzed in the two preceding chapters provides information on the average driver age, percent female drivers, percent nighttime driving, etc. for vehicles of a specific make-model and model year. Moreover, in Chapter 4, these averages were successfully used as control variables in regressions of accident rates by vehicle weight. Similar methods can be used in regressions of fatality rates per million vehicle years. Thus, even though the study of induced-exposure crashes did not, by itself, produce unbiased estimates of size-safety relationships, the effort was not wasted, because the information will be used to control the analyses of fatality rates per million vehicle years. The analysis methods are explained in this chapter, and the results are presented in Chapter 6.

5.2 Data reduction

A file of fatal crash involvements of 1985-93 passenger cars, specifying the make-model (CG, MM2), body style (BOD2), model year (MY) and curb weight of the car, the number of fatalities in the crash, the type of fatal crash, and the State and calendar year was derived from the 1989-93 Fatal Accident Reporting System [10] by exactly the same process as in Section 2.5. So was a file of light trucks involved in fatal crashes. The only difference is that the data in Section 2.5 were limited to 11 States in certain calendar years, while these files include all 50 States and the District of Columbia for the entire 1989-93 calendar years. The files contained records of 77,436 passenger cars and 42,002 light trucks. That is almost four times as large a fatality sample as was available for the analyses of Chapter 2. The distribution of the fatal involvements by type of crash was as follows:

	Crash Types (Table 2-1)	Cars	Light Trucks
Principal rollover	11	4,329	4,765
Hit object	12-17,81	16,818	8,018
Ped-bike-motorcycle	21,22	9,502	5,475
Hit big truck	31-39	5,020	2,284
Hit passenger car	41-59	19,190	11,335
Hit light truck	61-79	9,816	4,156
Other	91,98,99	12,761	5,969

The first six groups of crashes in the preceding table are the ones that will be analyzed, one at a time, in this chapter. The "other" category includes collisions of three or more vehicles, collisions involving two or more vehicles plus a pedestrian, and collisions with a vehicle of unknown type; those records are not used in the regression analyses of this chapter. The car-hit-car category is numerous beyond its proportion of overall fatalities, because each collision of two 1985-93 cars generates two records on the fatality file, one with car no. 1 as the "case" vehicle, and the other with car no. 2 as the "case" vehicle.

Files of 1985-93 passenger cars and light trucks, specifying the number of registered vehicles by make-model (CG, MM2), body style (BOD2 - cars only), model year (MY), State and calendar year (CY) were derived from the Polk's 1989-93 *National Vehicle Population Profiles* [26] by exactly the same process as in Section 4.2, but this time including all 50 States and the District of Columbia for the entire 1989-93 calendar years. The files comprised 313 million car registration years and 131 million light-truck registration years.

The regression analyses of Chapters 2-4 were based on 11 States. There were 10 dichotomous control variables: one for each State except Florida (the baseline State; Florida crashes were indicated by setting all ten control variables to zero). Now, with 50 States and the District of Columbia in the analysis, an expansion to 50 control variables would result in too many small cells. Instead, States were clustered into five groups, based on their fatality rates. Table 5-1 ranks the States according to the ratio of 1989-93 traffic accident fatalities per million vehicles registered in 1993, ranging from Connecticut (667) to Arkansas (1970). In general, Northern and highly urbanized States had the lowest fatality rates per million registered vehicles. The rank-order list was split into five **State Groups**, each comprising approximately equal numbers of 1989-93 fatalities. State Group 1, the 14 States with the lowest fatality rates, had an aggregate rate of 807, while State Group 5, the 11 States with the highest fatality rates, had an overall rate of 1522. State group is an important control variable. Without it, the size-safety analyses would be biased in favor of the smaller vehicles, which tend to be more popular in the highly urbanized areas, where fatality rates are intrinsically the lowest. State group will appear in the regression analyses as four dichotomous control variables (STGP1, STGP2, STGP4, STGP5). State group 3, the "median" group, is indicated by zeros on all four variables.

TABLE 5-1: DEFINITIONS OF THE FIVE STATE GROUPS BASED ON 1989-93 FATALITIES PER MILLION VEHICLES REGISTERED IN 1993

STATE GROUP 1
38,620 1989-93 fatalities
47,864,000 vehicles in 1993
Fatality rate: 807

	Fat. Rate
Connecticut	667
Rhode Island	668
North Dakota	678
New Jersey	713
Massachusetts	765
Minnesota	771
Washington	790
New Hampshire	800
Iowa	815
Ohio	846
Virginia	869
Maryland	898
Colorado	904
Hawaii	906

STATE GROUP 2
43,259 1989-93 fatalities
44,462,000 vehicles in 1993
Fatality rate: 973

Illinois	923
Wisconsin	941
Michigan	970
Nebraska	974
Pennsylvania	974
Alaska	988
Oregon	989
South Dakota	995
Maine	1004
New York	1011

STATE GROUP 3
38,824 1989-93 fatalities
37,290,000 vehicles in 1993
Fatality rate: 1041

	Fat. Rate
California	1024
Indiana	1025
Montana	1026
Kansas	1042
Delaware	1071
Vermont	1077
Utah	1090
D.C.	1098
Oklahoma	1133
Idaho	1142

STATE GROUP 4
47,869 1989-93 fatalities
39,361,000 vehicles in 1993
Fatality rate: 1216

Georgia	1180
Tennessee	1181
Wyoming	1195
Texas	1210
Missouri	1234
Florida	1254

STATE GROUP 5
42,339 1989-93 fatalities
27,819,000 vehicles in 1993
Fatality rate: 1522

North Carolina	1257
Kentucky	1350
Louisiana	1401
Arizona	1459
Nevada	1510
Alabama	1567
New Mexico	1706
West Virginia	1706
South Carolina	1729
Mississippi	1852
Arkansas	1970

The key independent variables for the regression analyses of this chapter, curb weight or track width, as well as some principal control variables (YOUNGDRV, OLDMAN, OLDWOMAN, FEMALE, NITE, RURAL, AIRBAG, ABS2, ABS4, AWD) are derived from the **induced-exposure accident files** of 559,871 cars and 188,629 light trucks, described in Section 2.4. (All control variables are defined in Section 3.1.) In other words, it is assumed that the distribution of driver age and sex in induced-exposure crashes in the 11 States is representative, at least in relative terms, of the general driving public in the United States: since drivers of Dodge Stealths are younger than drivers of Cadillacs and more likely to be male than drivers of Subarus in the 11 States, that is assumed to be true of the entire United States, as well. The induced-exposure crashes are **weighted**, as described in Section 4.4, to give each of the 11 States a contribution proportional to its share of the vehicle registrations, and to prevent States with low reporting thresholds from dominating the data. For any aggregation of vehicles used as a data point in the regression analyses of this chapter - e.g., for a CG-MM2-BOD2-MY combination, or just a CG-MM2 combination - the weighted averages of CURBWT, TRAKWDTH, YOUNGDRV, OLDMAN, OLDWOMAN, FEMALE, NITE, RURAL, AIRBAG, ABS2, ABS4, and/or AWD for the induced-exposure crashes involving those vehicles are entered as values for the independent variables for that data point (and for RURAL, the Michigan induced-exposure cases are not used in computing the average, since the variables were always set to zero, there).

Vans weighing over 4000 pounds are **excluded** throughout the analyses of this chapter, as in Chapter 4, because of the problems encountered in meshing the Polk and FARS data for those vehicles.

5.3 Unadjusted fatality rates per million vehicle years

Before any regression analyses, it is instructive to inspect the basic, unadjusted size-safety trends for the six fundamental types of crashes. Fatal involvements and registration data are grouped by curb weight or track width, and the fatality rate per million vehicle years is graphed for each class interval of vehicle size.

Figure 5-1 graphs the fatality rate in **principal rollovers** for **passenger cars** by **curb weight**. Cars were grouped into 100-pound weight intervals (or 300 pound intervals at the upper and lower ends, where the data are sparser), with centroids ranging from 1800 to 4100 pounds. The vertical axis is the logarithm of the fatality rate. Figure 5-1 shows a very strong, highly linear trend of decreased fatality risk as weight increases: about a .07 drop in the logarithm for every 100 pound weight increase. In other words, the increase in the **unadjusted** fatality rate is between 7 and 8 percent for every 100 pound weight reduction. But the unadjusted data exaggerate the weight-safety effect. The smallest cars are popular with younger drivers, who tend to driving behaviors that lead to rollovers. After control for driver age and sex, it is likely that the effect of vehicle weight will be not be as strong. Figure 5-1a shows an exceedingly strong, nearly linear relationship between **track width** and the rollover fatality rate.

Figure 5-2 graphs the rate of passenger car fatalities in collisions with **objects** (crash types 12-17 and 81 in Table 2-1), by curb weight. Visually, the downward trend with increasing weight is nearly as strong as for rollovers. Contributing to the appearance of strength is the large sample

FIGURE 5-1

PASSENGER CARS: FATALITIES IN PRINCIPAL ROLLOVERS
PER MILLION VEHICLE REGISTRATION YEARS, BY CURB WEIGHT

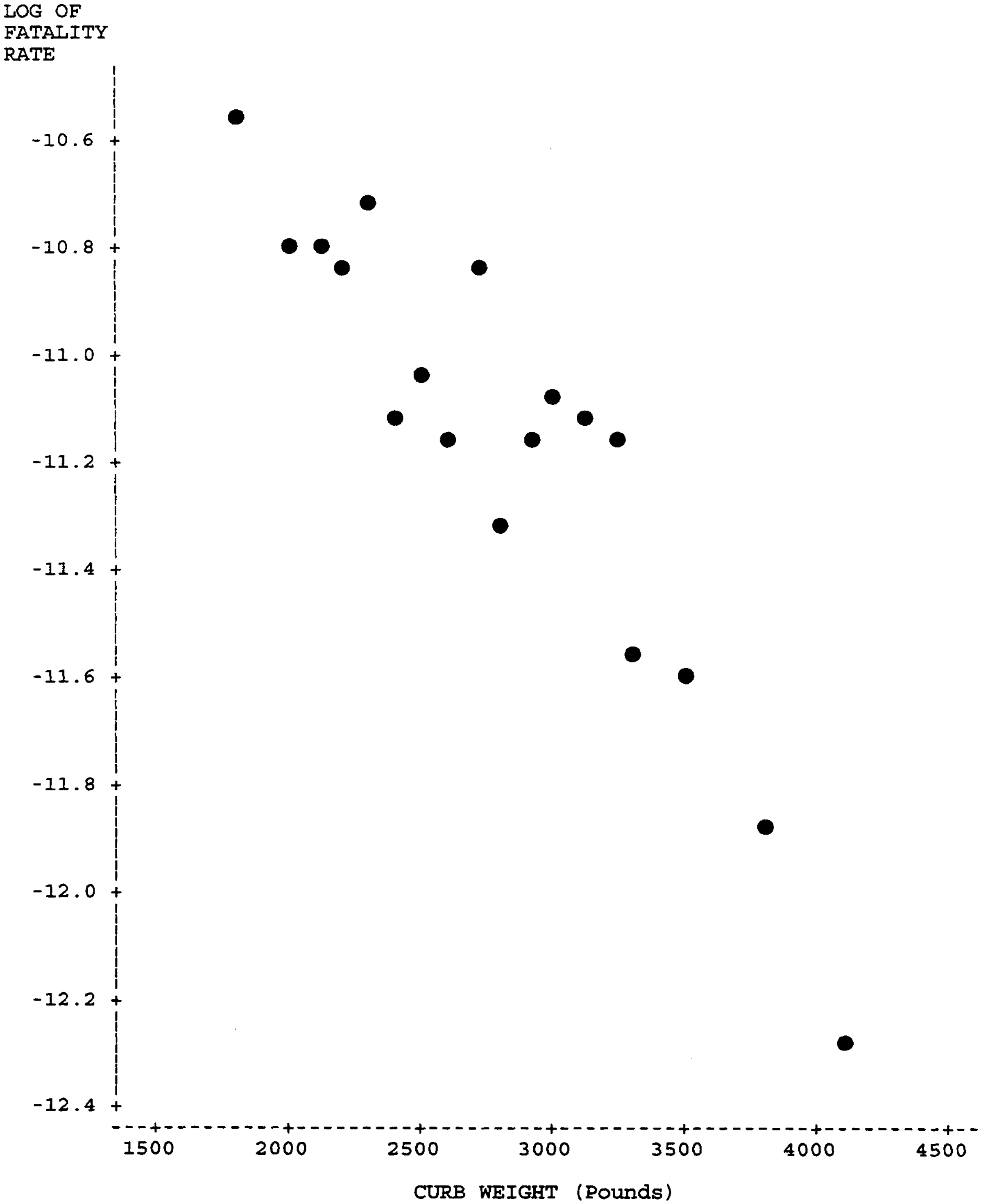


FIGURE 5-1a

PASSENGER CARS: FATALITIES IN PRINCIPAL ROLLOVERS
PER MILLION VEHICLE REGISTRATION YEARS, BY TRACK WIDTH

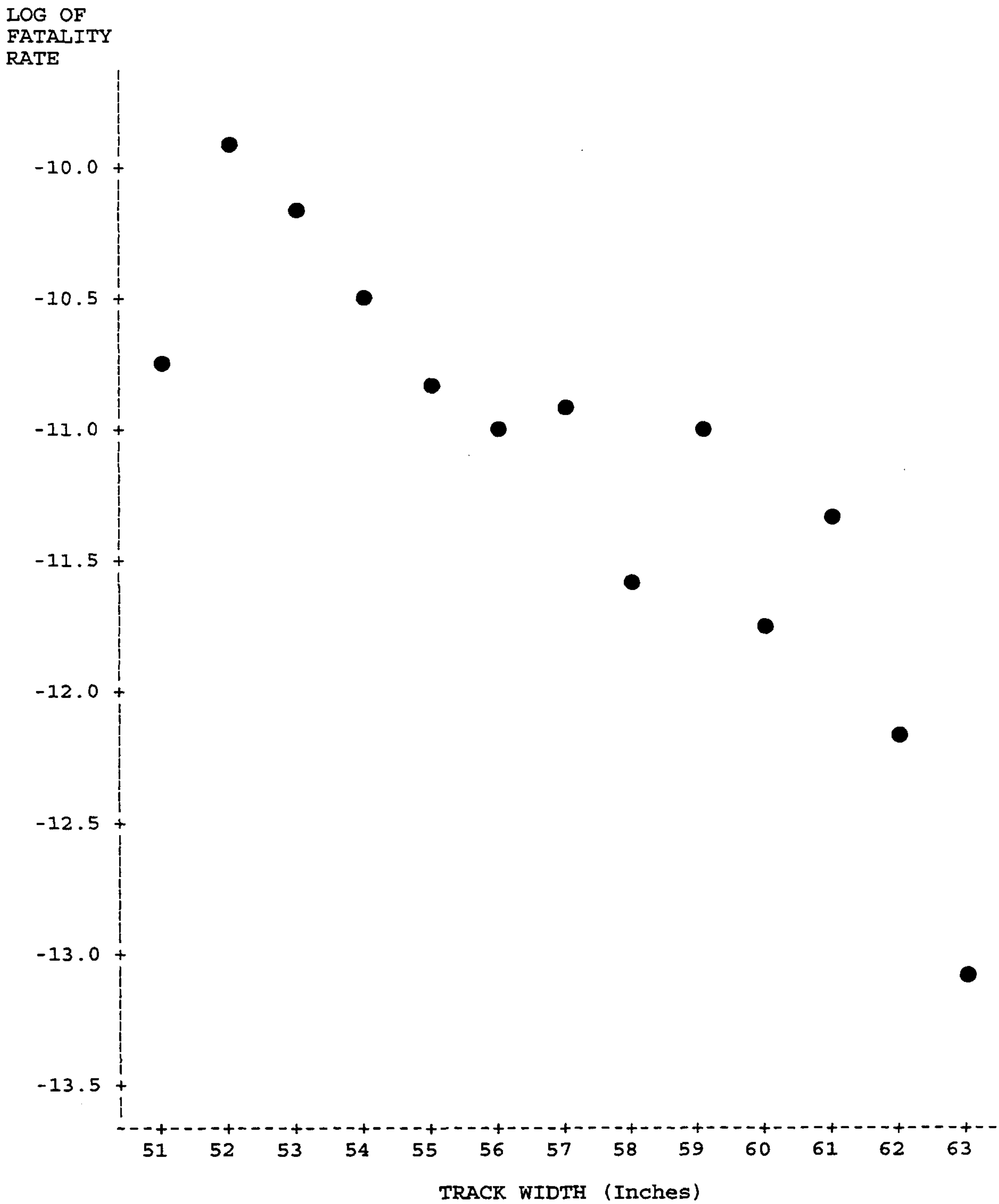
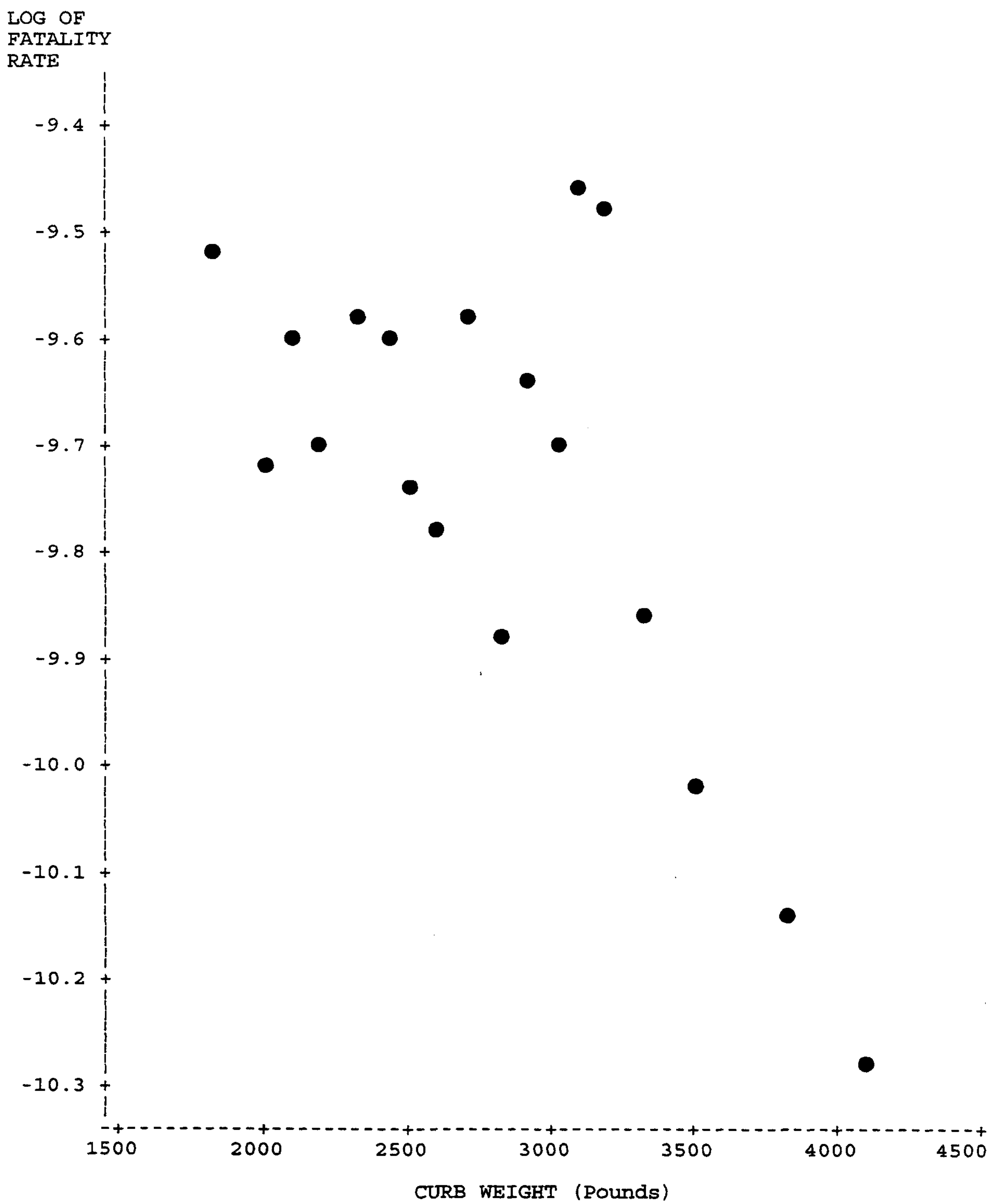


FIGURE 5-2

PASSENGER CARS: FATALITIES IN COLLISIONS WITH OBJECTS PER MILLION VEHICLE REGISTRATION YEARS, BY CURB WEIGHT



size of fixed-object fatalities, which reduces scatter in the data points. But in absolute terms, the unadjusted size-safety effect is weaker than for rollovers. as evidenced by the vertical scale (log of fatality rate). Here, the data points drop from -9.5 on the left to -10.3 on the right, corresponding to a

$$1 - \exp(-0.8) = 55 \text{ percent}$$

reduction of fatalities from the lightest to the heaviest cars. But in Figure 5-1, they dropped from - 10.6 to -12.4, and in Figure 5-1a from -10.0 to -13.0, corresponding to 85 percent and 95 percent **unadjusted** fatality reductions. The unadjusted effect is weaker for fixed-object collisions than for rollovers partly because the true size-safety effect is weaker, and partly because driver age is substantially less of a confounding factors here than for rollovers.

Figure 5-3 shows the trend in **pedestrian, bicyclist and motorcyclist** fatalities in collisions with passenger cars, per million car years, by curb weight of the car. The unadjusted data show a hint of a downward trend, but it is weaker than in the preceding figures, as evidenced by more scatter of the data points, including a real outlier at 3800 pounds. The vertical axis shows a drop of only 0.3 from the lightest to the heaviest cars. It is not clear what will happen after the data are adjusted for driver age, sex and other factors.

The trend of fatalities in collisions of cars with **big trucks** (over 10,000 pounds GVW), by curb weight of the car, is presented in Figure 5-4. Visually, and in absolute terms, the unadjusted data closely resemble the pedestrian trend. However, running into big trucks is more of an old-driver than a young-driver problem. That creates a bias against the larger cars. After adjustment for driver age, the trend in Figure 5-4 may become stronger **in favor of** large cars, unlike the trends for most of the other crash types.

Figure 5-5 considers collisions between **two passenger cars**. The fatality rate, which includes fatalities to occupants of **either** of the two cars in the collision, is tabulated by the weight of the "case" vehicle. The "other" vehicle is a passenger car of unspecified weight. Figure 5-5 is the first graph that does not show any clear weight-safety trend. There is a lot of scatter, and the range of the vertical axis is small. The scatter is not due to lack of sample size, since there are more FARS records for this type of crash than any other. Figure 5-5a graphs the fatality trend for occupants of each vehicle. As the weight of the case vehicle increases, the fatality rate for its occupants strongly decreases, but the fatality rate for occupants of the "other" car increases at about the same rate. The net fatality risk for occupants of both cars remains almost constant.

Figure 5-6 studies collisions between **a passenger car and a light truck**. The fatality rate, which includes fatalities in **either** vehicle, is tabulated by the weight of the car (the "case" vehicle). The "other" vehicle is a light truck of unspecified weight. Unlike Figure 5-5, there is a very strong trend of reduced fatalities as car weight increases. Figure 5-6a graphs the fatality trend for occupants of each vehicle. As in Figure 5-5a, when the weight of the case vehicle (the car) increases, the fatality rate for its occupants decreases, and the fatality rate in the "other" vehicle (the light truck) increases. Unlike Figure 5-5a, 80 percent of the fatalities are occupants of the case vehicles (the cars). In most collisions, the light truck is the heavier, structurally more aggressive vehicle, and it has the additional advantage that its drivers are preponderantly male

FIGURE 5-3

PEDESTRIAN, BICYCLIST AND MOTORCYCLIST FATALITIES
IN COLLISIONS WITH **PASSENGER CARS**
PER MILLION CAR REGISTRATION YEARS, BY CURB WEIGHT OF THE CAR

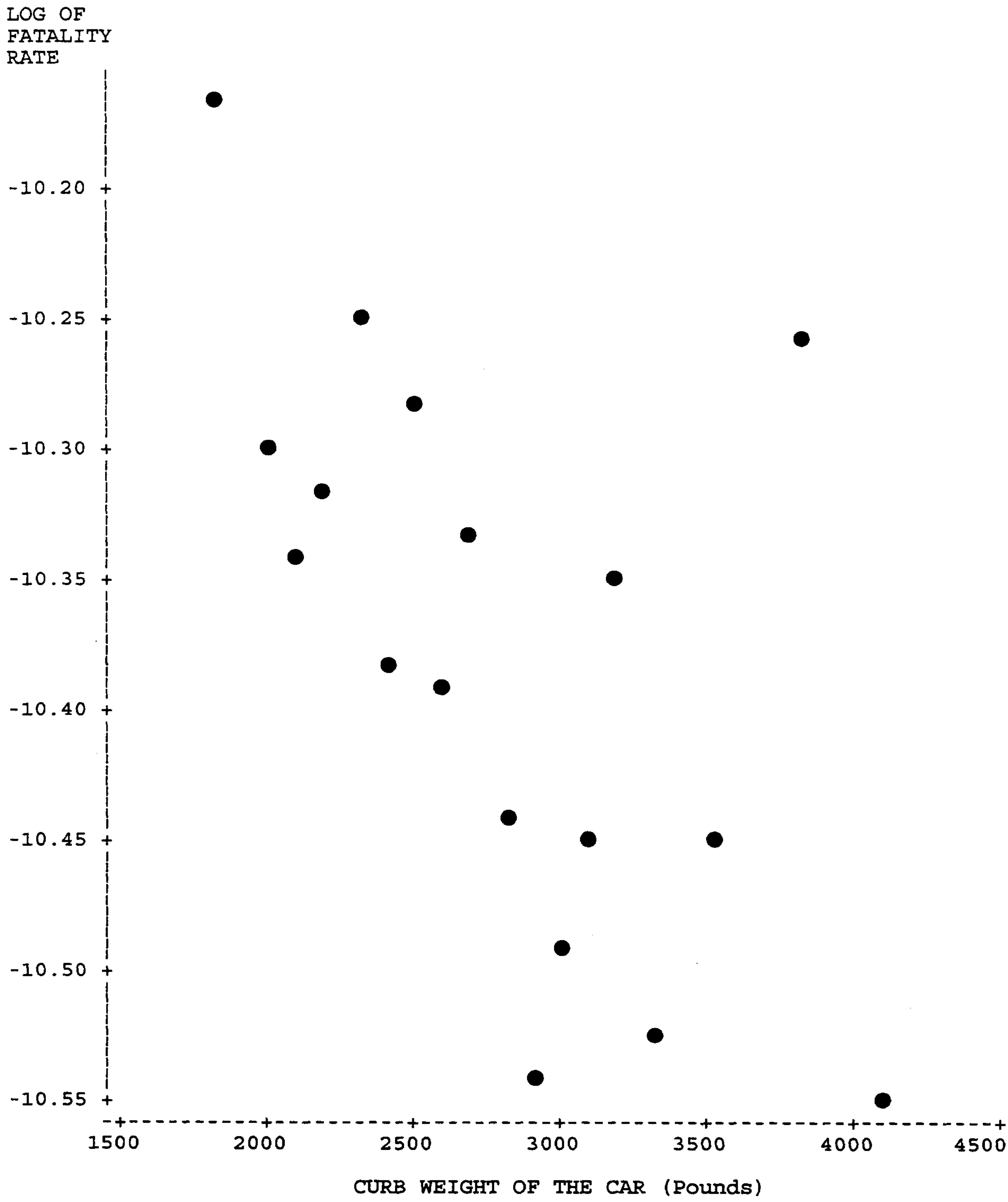


FIGURE 5-4

PASSENGER CARS: FATALITIES IN COLLISIONS WITH BIG TRUCKS PER MILLION CAR REGISTRATION YEARS, BY CURB WEIGHT OF THE CAR

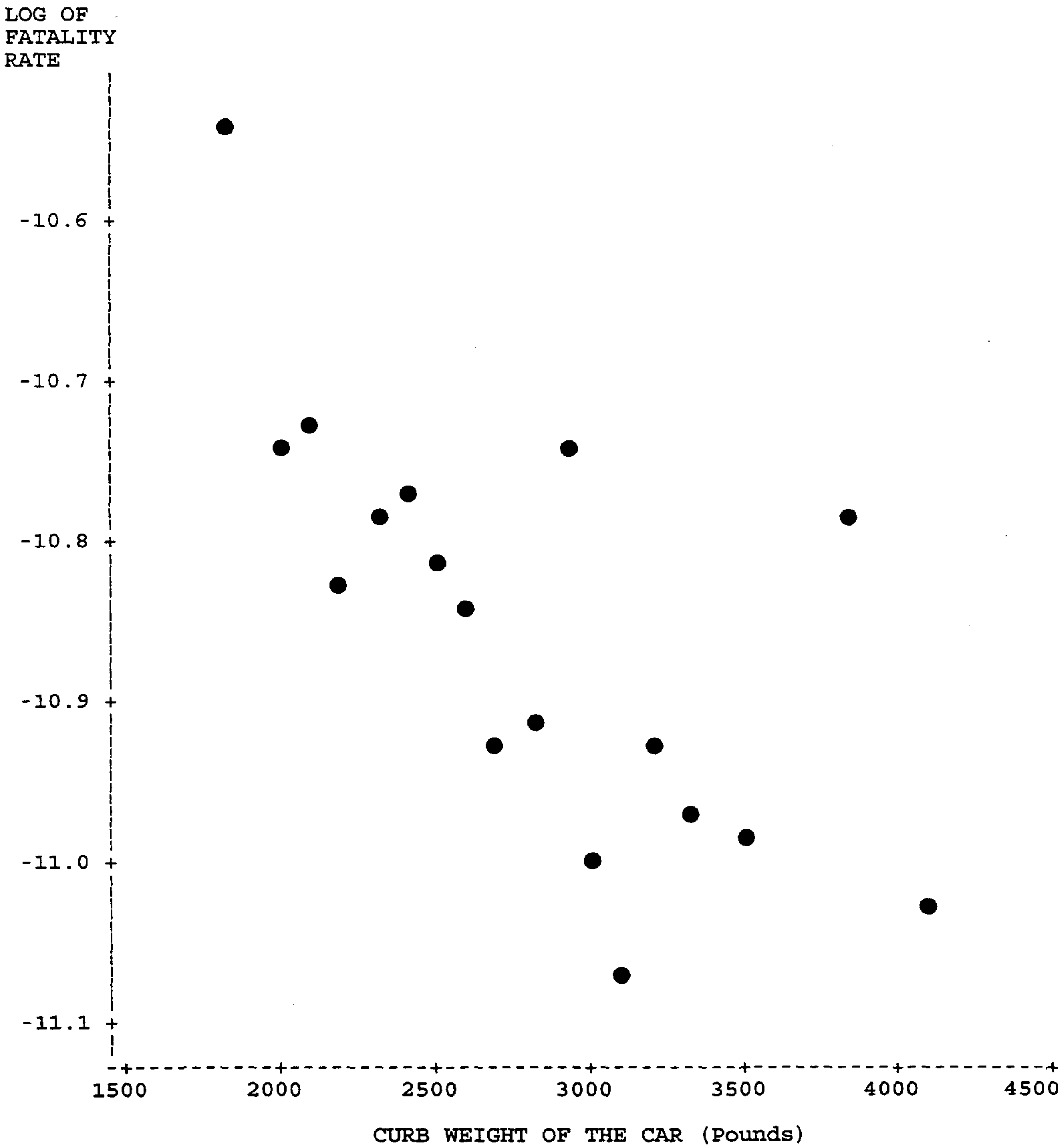


FIGURE 5-5

PASSENGER CARS
FATALITIES IN **CAR-TO-CAR** COLLISIONS, PER MILLION CAR REGISTRATION YEARS
BY WEIGHT OF THE "CASE" CAR

(total fatalities in the crash)

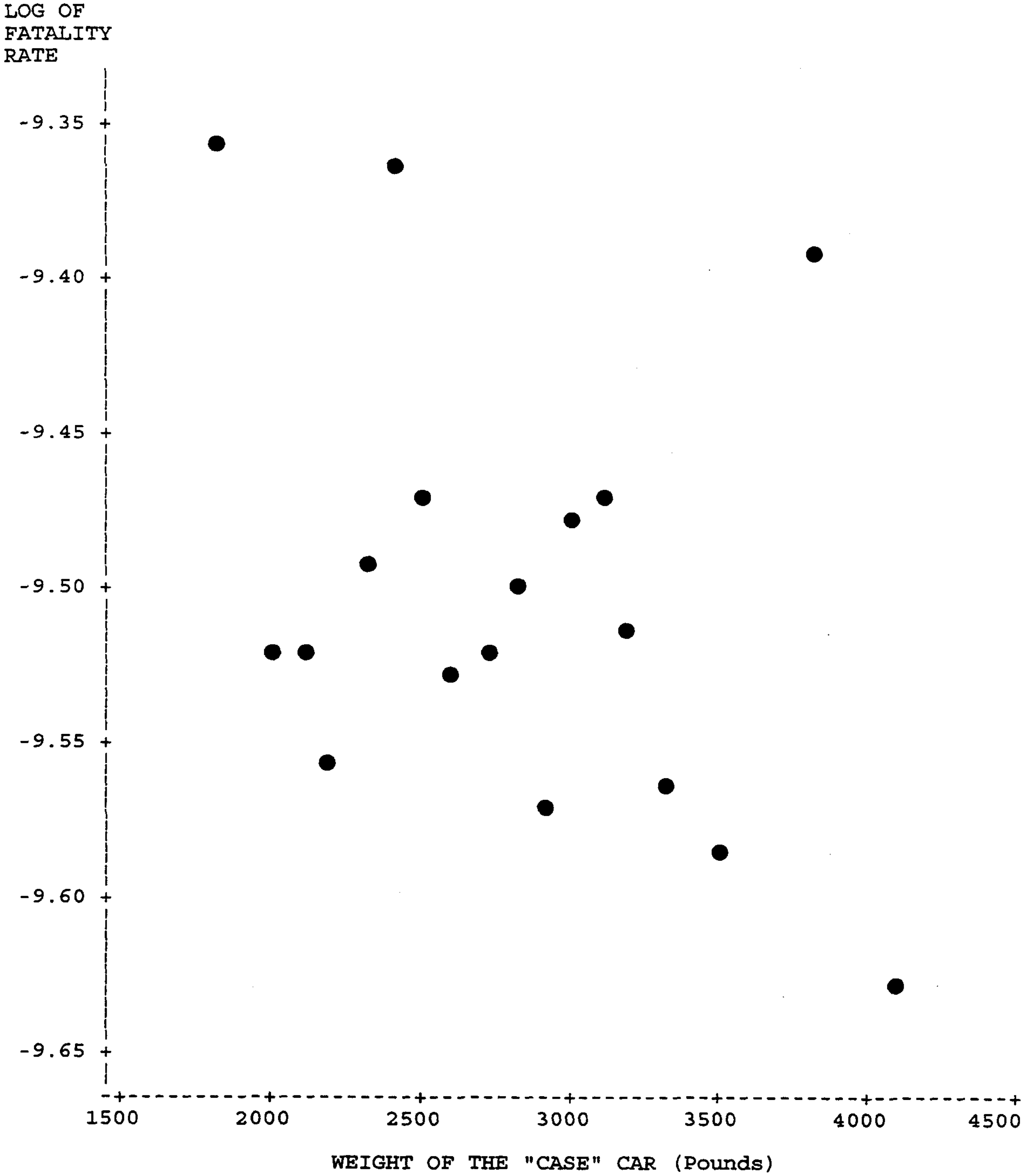


FIGURE 5-5a

PASSENGER CARS
FATALITIES IN **CAR-TO-CAR** COLLISIONS, PER MILLION CAR REGISTRATION YEARS
BY WEIGHT OF THE "CASE" CAR

('●' = fatalities in the crash
'©' = case vehicle occupant fatalities
'☞' = other vehicle occupant fatalities)

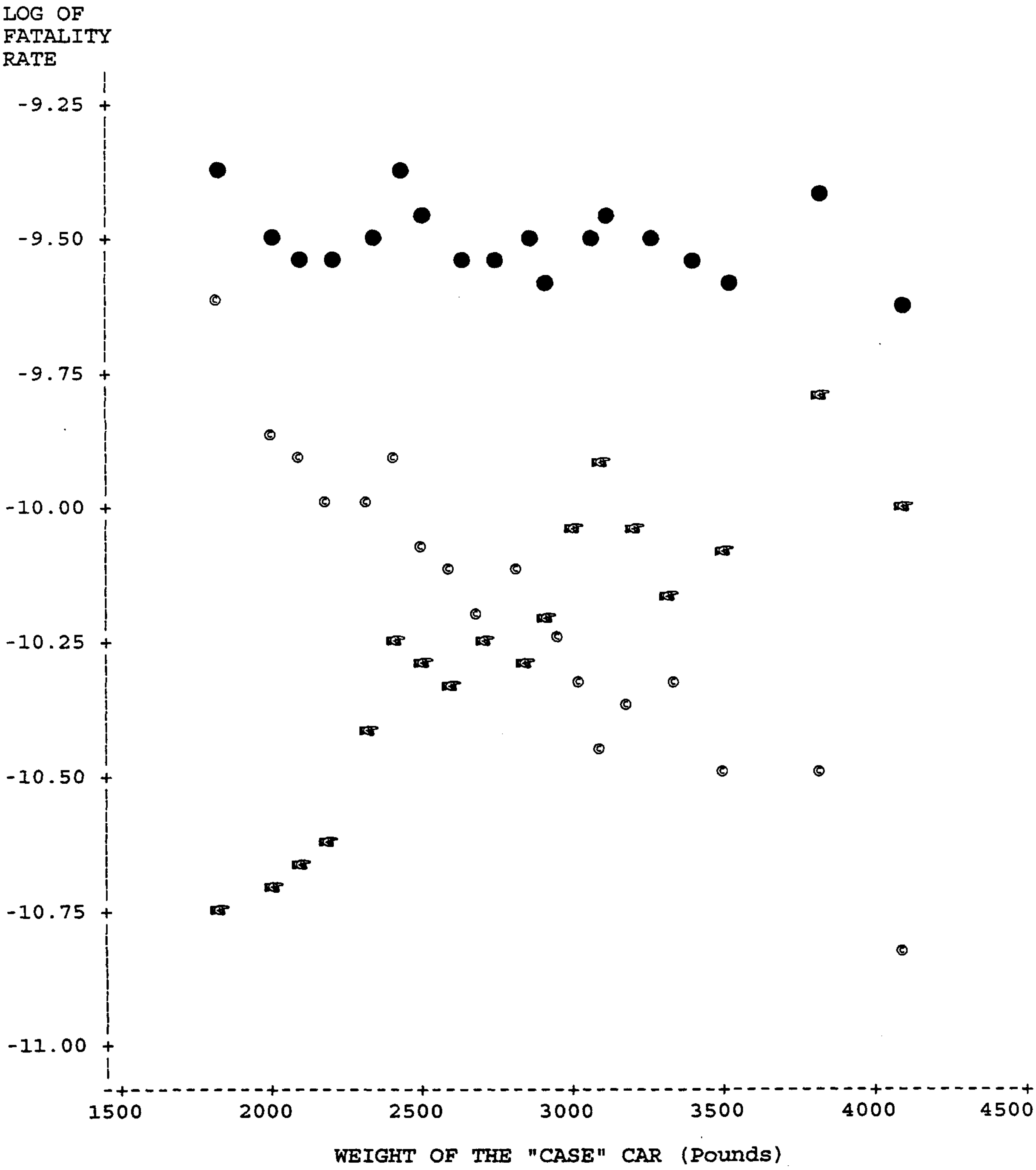


FIGURE 5-6

PASSENGER CARS: FATALITIES IN COLLISIONS WITH LIGHT TRUCKS PER MILLION CAR REGISTRATION YEARS, BY CURB WEIGHT OF THE CAR

(total fatalities in the crash)

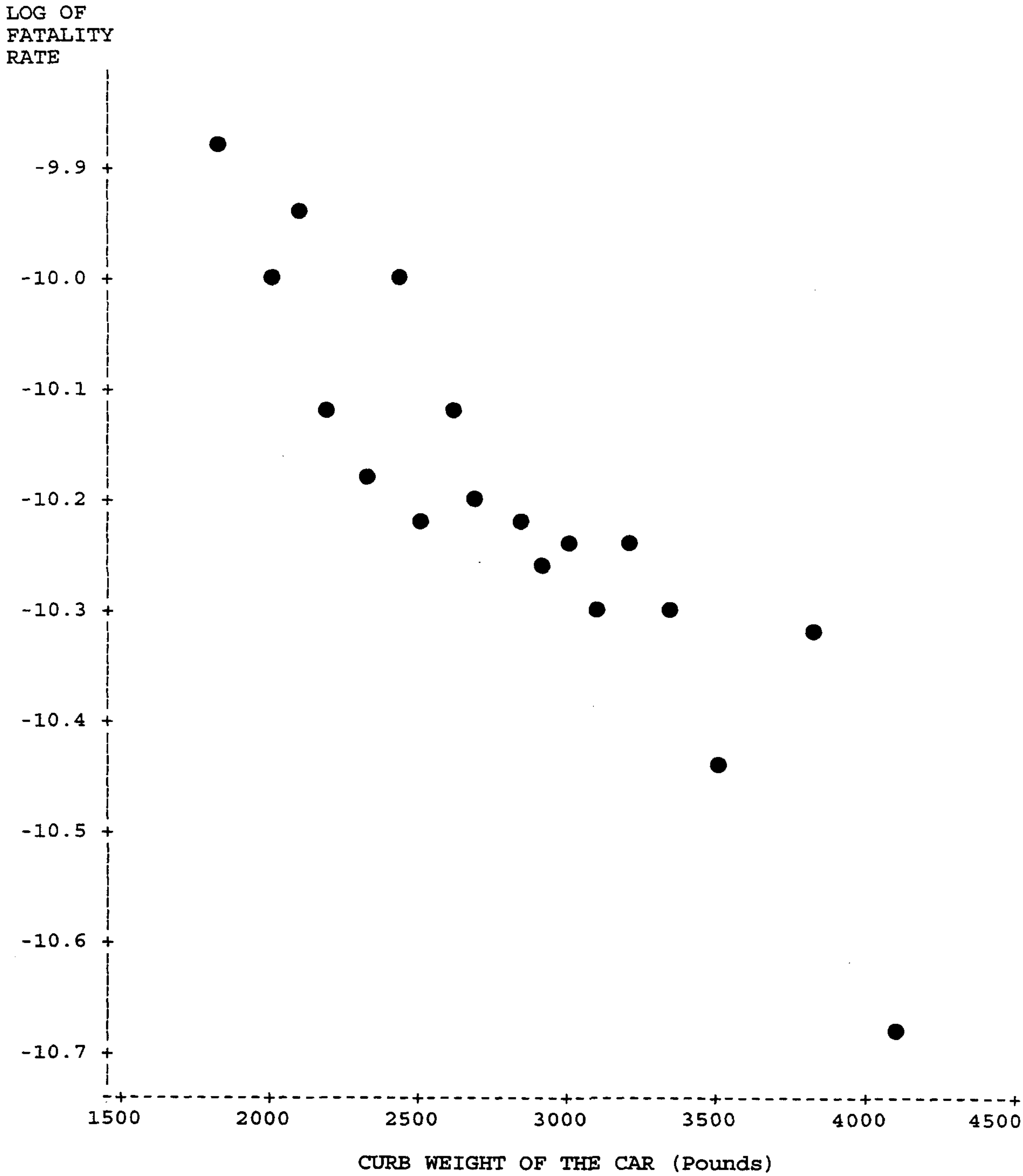
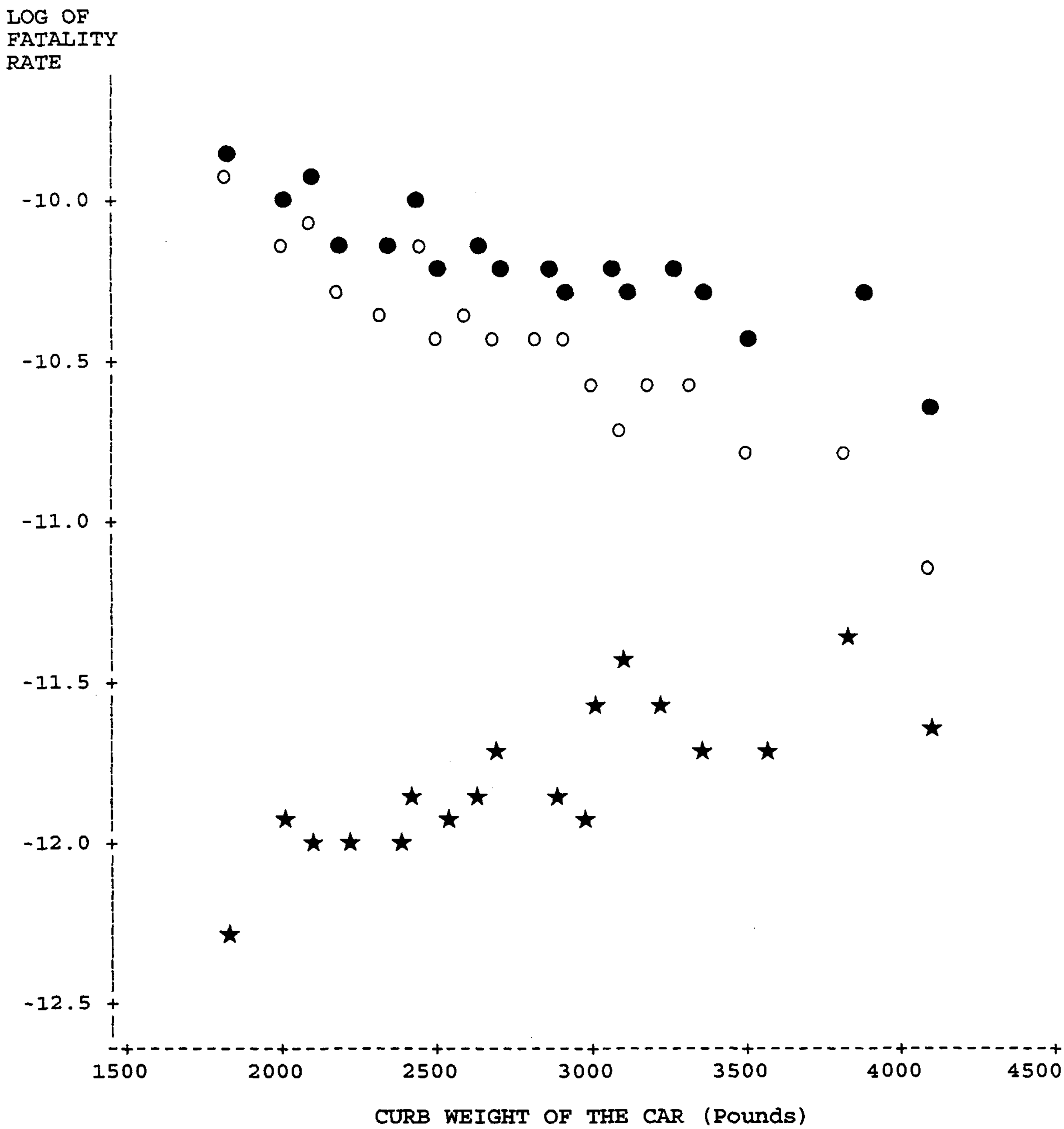


FIGURE 5-6a

PASSENGER CARS: FATALITIES IN COLLISIONS WITH LIGHT TRUCKS PER MILLION CAR REGISTRATION YEARS, BY CURB WEIGHT OF THE CAR

('●' = fatalities in the crash
'★' = light truck occupant fatalities
'O' = passenger car occupant fatalities)



and often young (lower vulnerability to fatal injury). The increase in truck occupant fatalities, as car weight increases, hardly compensates for the reduction in car occupant fatalities.

Figures 5-7 - 5-12 present comparable data for **light trucks**. The size-safety effect in the **unadjusted** data is less visible than for passenger cars, due to four factors: (1) The true size-safety effect is sometimes smaller for light trucks than cars. (2) The confounding effect of driver age (tendency of younger people to driver smaller vehicles) is less strong for trucks. (3) The size of the fatal accident sample is about half as large for cars, increasing scatter in the graphs. (4) The diversity of the truck fleet also increases scatter in these graphs; one 100-pound weight group may contain a heavy proportion of SUVs, and the next, a lot of vans.

Figure 5-7 graphs the fatality rate of light trucks in principal rollovers, by curb weight. There is, perhaps, a hint of a downward trend as truck weight increases, but nothing like the linear trend for cars. Figure 5-7a shows the rollover rate by track width. There seems to be a stronger downward trend, except for one or two outliers.

Figure 5-8 shows a fairly strong trend of reduced fatalities in collisions with objects as truck weight increases. Here, where there are ample data, the visible trend is not too much weaker than for passenger cars (Figure 5-2). The heaviest trucks all have low rates and the lightest all have high rates.

Figure 5-9 graphs the pedestrian, bicyclist and motorcyclist fatality rate in collisions with light trucks. While the data tend to go in several directions at the same time, there is a fairly definite hint that the larger trucks have **higher** fatality rates.

Figure 5-10 displays the fatality rate in collisions of light trucks with big trucks, by weight of the light truck. Although the results are somewhat scattered (small samples of fatalities), there is a rather unequivocal trend of lower fatality rates as the light trucks get heavier.

Figure 5-11 graphs the fatality rate in collisions between **a light truck and a passenger car**, by the weight of the light truck (the "case" vehicle). Fatalities to occupants of **either** vehicle are included. This graph is, so to speak, the mirror image of Figure 5-6. After some scatter at the lower weights, a very strong trend of increased fatalities with increased truck weight emerges. Figure 5-11a graphs the fatality trend for occupants of each vehicle. The larger light trucks provide superb protection for their own occupants, while the fatality risk for the car occupants continues to increase. Since 80 percent of the fatalities in these crashes are car occupants, the reduction in truck occupant deaths hardly compensates for the increase in car occupant fatalities.

Figure 5-12 studies collisions between two light trucks. The fatality rate (which comprises occupants of either truck) is graphed by the weight of the "case" vehicle. Figure 5-12 does not show any meaningful weight-safety trend.

In general, Figures 5-1 - 5-12 show that reducing a vehicle's weight increases net risk in collisions with entities substantially bigger than that vehicle (cars with objects, big trucks and light trucks; light trucks with objects and big trucks). Reducing a vehicle's weight **reduces** net risk in collisions with entities substantially smaller than that vehicle (cars with pedestrians,

FIGURE 5-7

LIGHT TRUCKS: FATALITIES IN PRINCIPAL ROLLOVERS
PER MILLION VEHICLE REGISTRATION YEARS, BY CURB WEIGHT

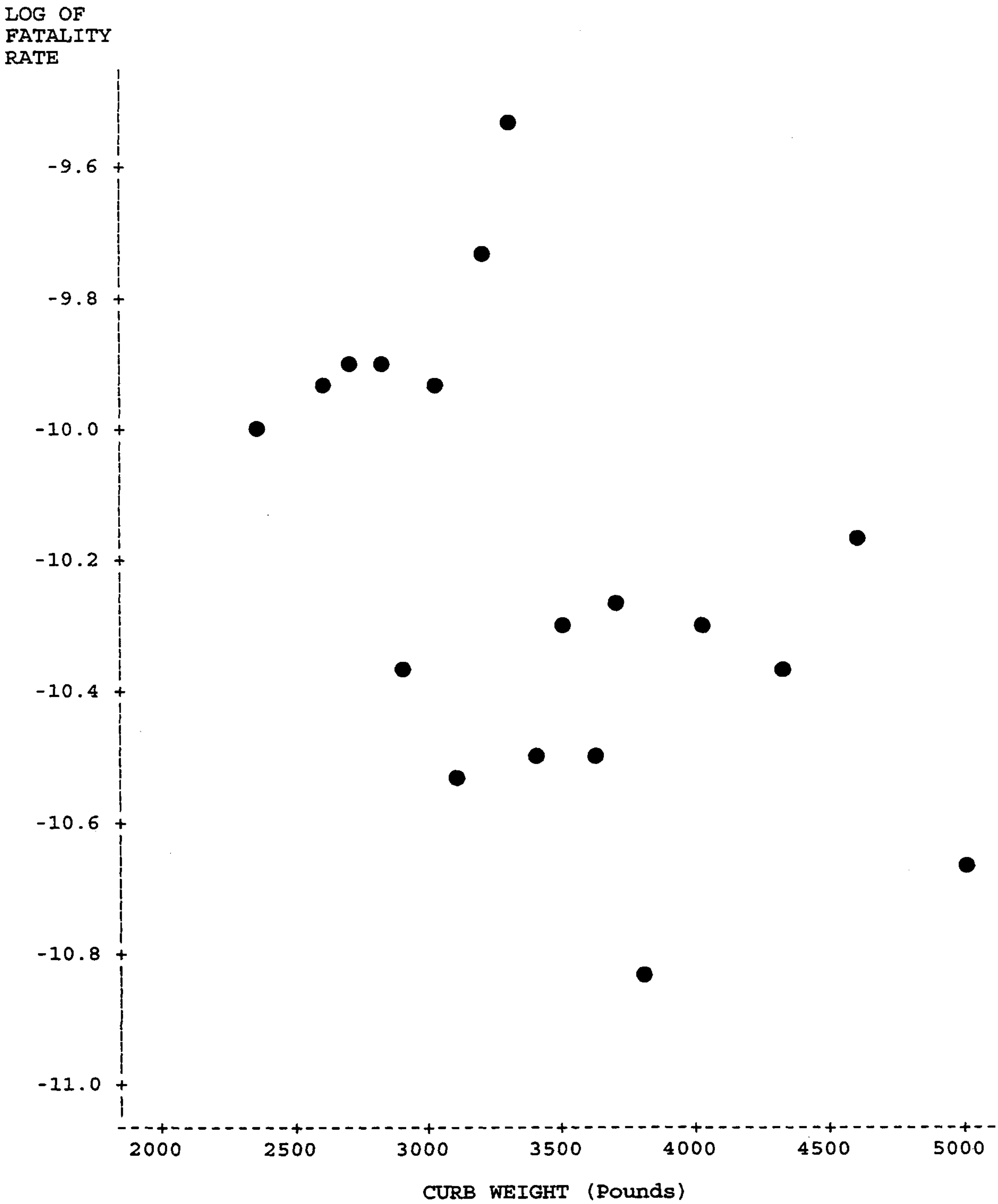


FIGURE 5-7a

LIGHT TRUCKS: FATALITIES IN PRINCIPAL ROLLOVERS
PER MILLION VEHICLE REGISTRATION YEARS, BY TRACK WIDTH

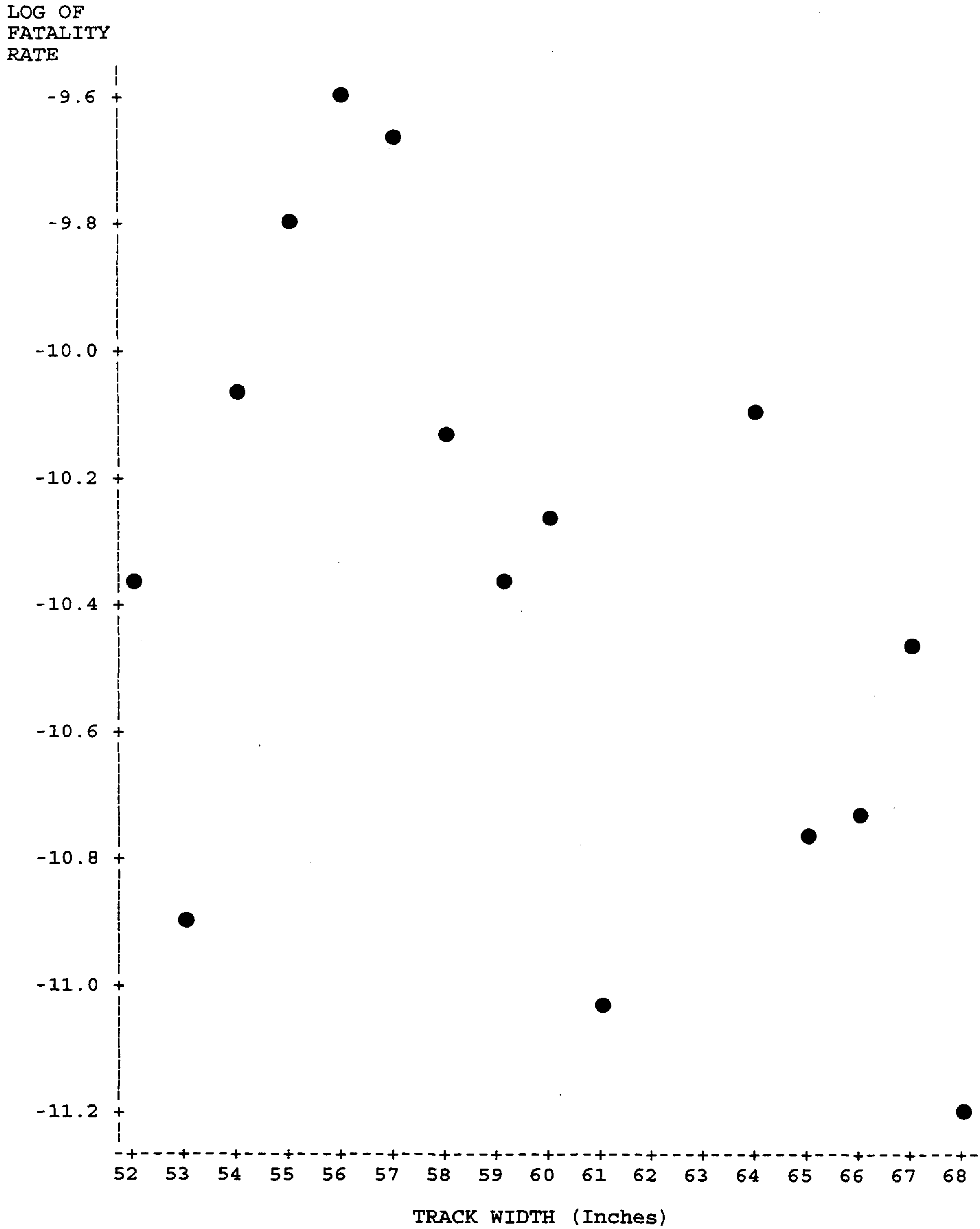


FIGURE 5-8

LIGHT TRUCKS: FATALITIES IN COLLISIONS WITH OBJECTS
PER MILLION VEHICLE REGISTRATION YEARS, BY CURB WEIGHT

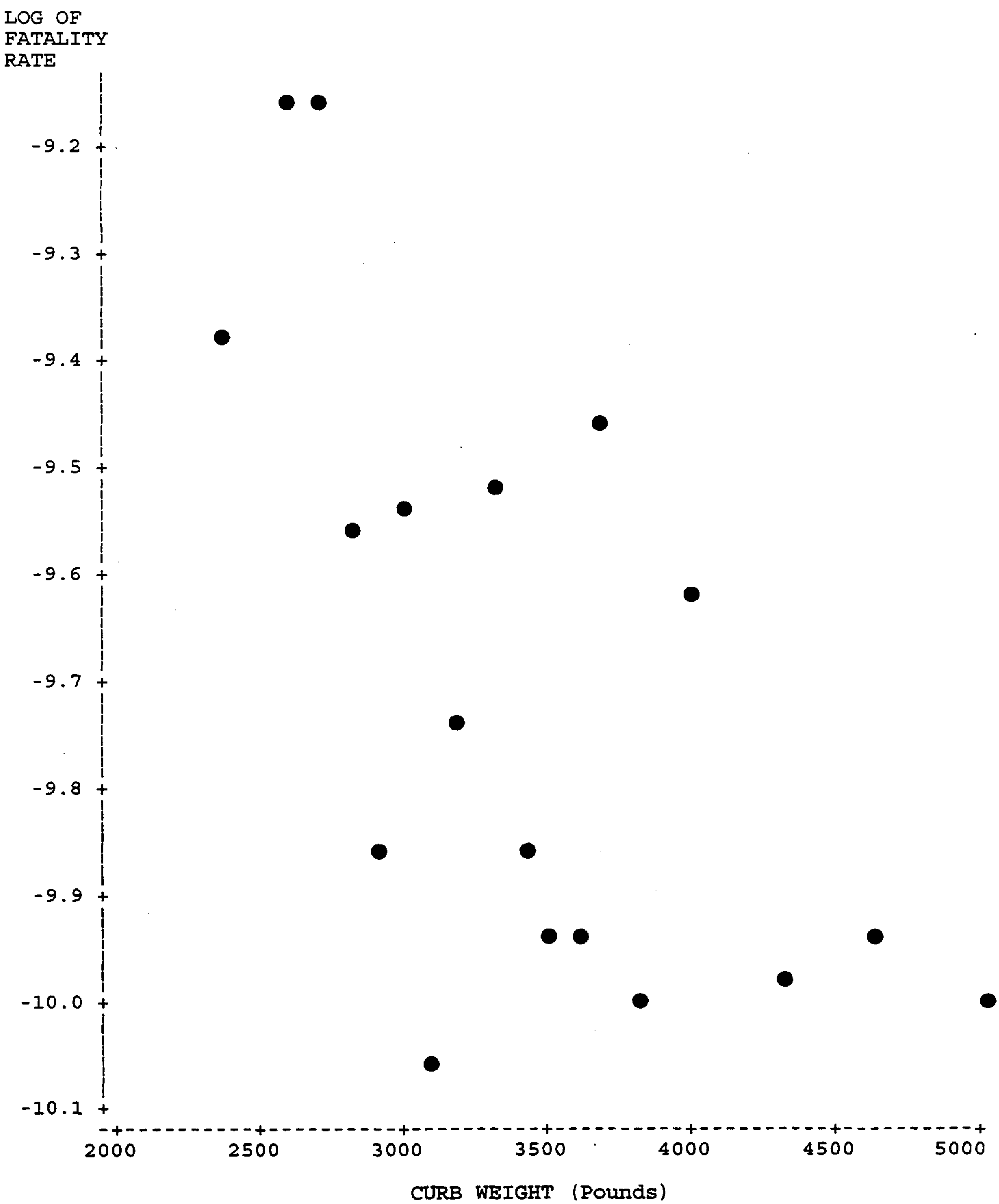


FIGURE 5-9

PEDESTRIAN, BICYCLIST AND MOTORCYCLIST FATALITIES
IN COLLISIONS WITH **LIGHT TRUCKS**
PER MILLION LIGHT TRUCK REGISTRATION YEARS, BY CURB WEIGHT OF THE LIGHT TRUCK

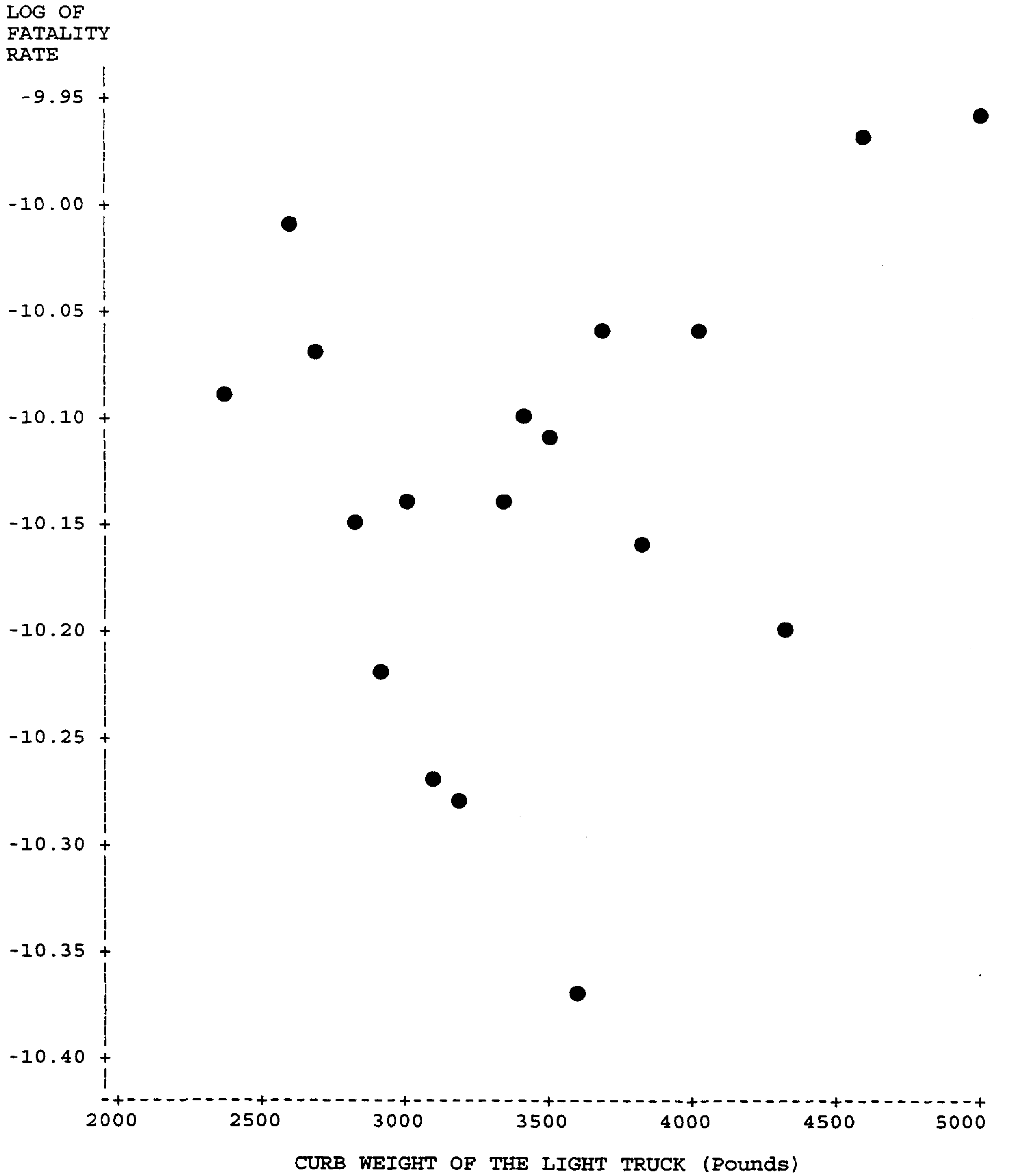


FIGURE 5-10

LIGHT TRUCKS: FATALITIES IN COLLISIONS WITH BIG TRUCKS
PER MILLION LIGHT TRUCK REGISTRATION YEARS, BY CURB WEIGHT OF THE LIGHT TRUCK

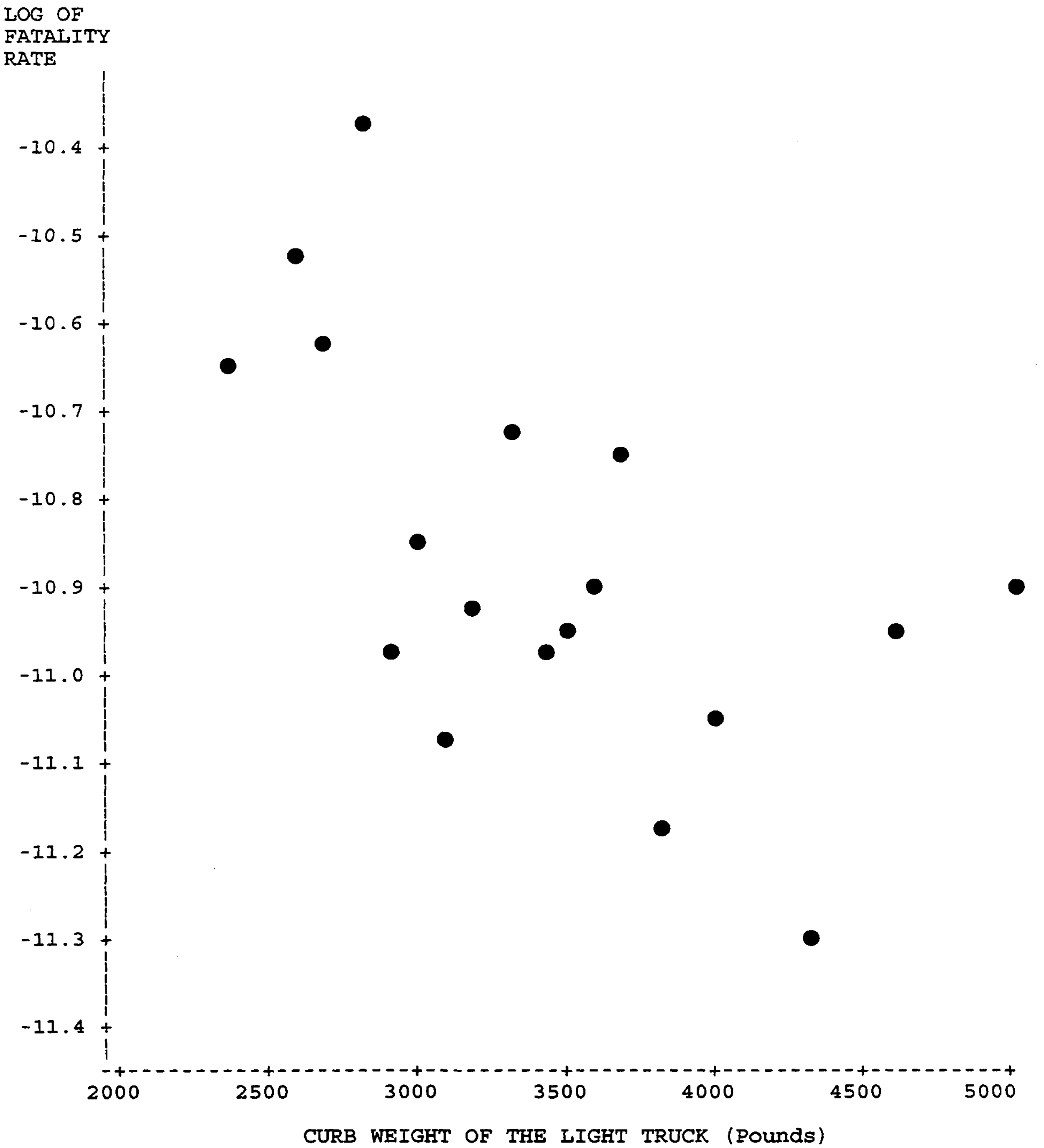


FIGURE 5-11

LIGHT TRUCKS: FATALITIES IN COLLISIONS WITH PASSENGER CARS
PER MILLION TRUCK REGISTRATION YEARS, BY CURB WEIGHT OF THE TRUCK

(total fatalities in the crash)

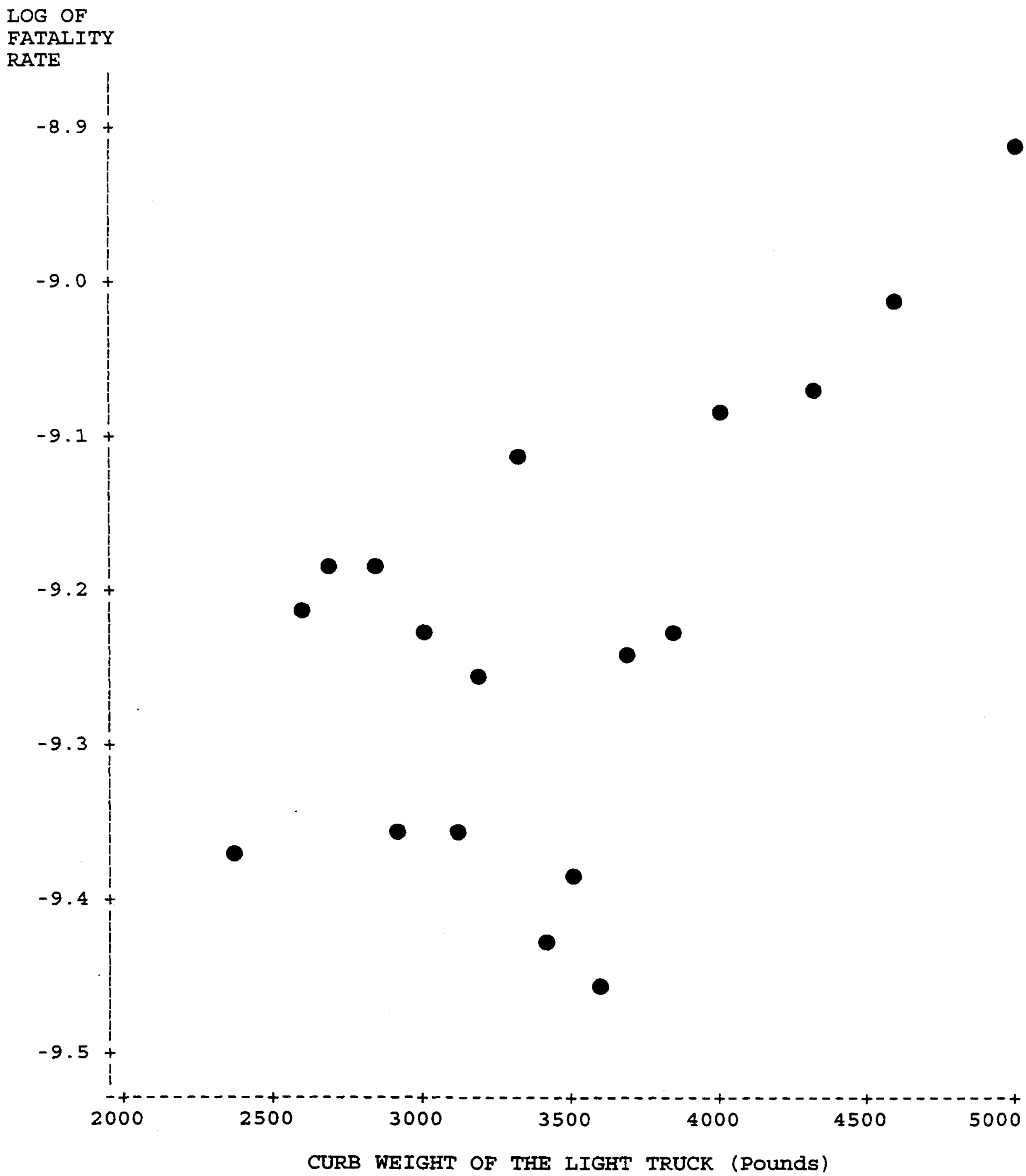


FIGURE 5-11a

LIGHT TRUCKS: FATALITIES IN COLLISIONS WITH PASSENGER CARS PER MILLION TRUCK REGISTRATION YEARS, BY CURB WEIGHT OF THE TRUCK

('●' = fatalities in the crash
'★' = light truck occupant fatalities
'O' = passenger car occupant fatalities)

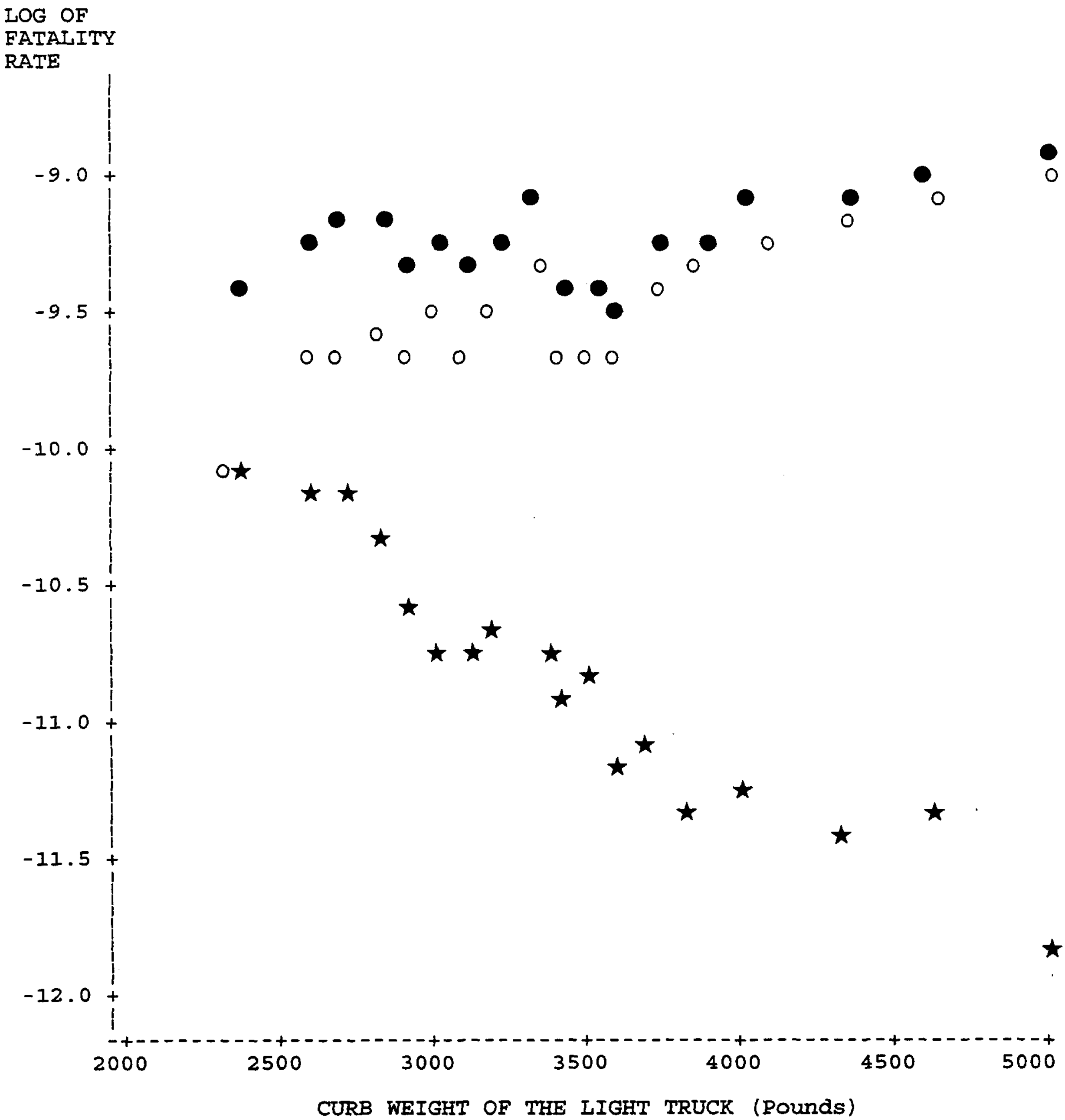
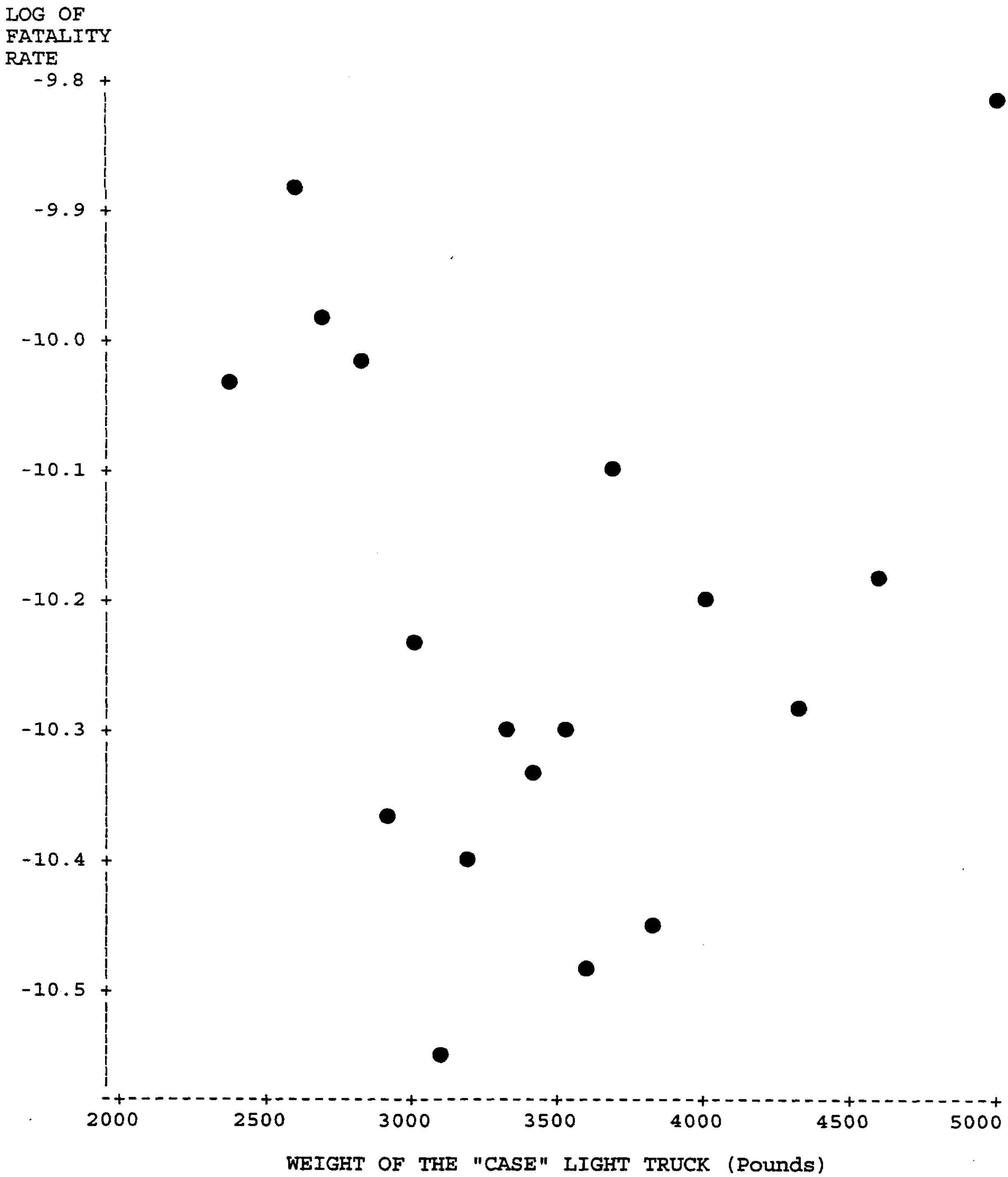


FIGURE 5-12

FATALITIES IN **LIGHT TRUCK-TO-LIGHT TRUCK** COLLISIONS
PER MILLION LIGHT TRUCK REGISTRATION YEARS
BY WEIGHT OF THE "CASE" LIGHT TRUCK

(total fatalities in the crash)



bicycles, motorcycles; light trucks with pedestrians, bicycles, motorcycles and cars). It has little effect on net risk in collisions with entities of about the same size (cars with cars; light trucks with light trucks).

5.4 Initial regressions of passenger car rollovers

The next task is to perform regression analyses on fatality rates, per million vehicle years, by curb weight (or track width), adjusting for the confounding effects of driver age, sex and other control variables. The procedure developed in Section 4.4 to analyze induced-exposure accident rates per 1000 vehicle years will serve as the initial paradigm. Fatality and registration data are aggregated into cells, and aggregate linear regressions are performed on the fatality rates in the cells. The regression analysis is performed in two steps. Step 1 calibrates the effect of vehicle age, State group and calendar year. Vehicle registration counts are adjusted upwards or downwards, based on the coefficients from Step 1. Step 2 aggregates the data by make-model-MY and calibrates the effect of curb weight (or track width), driver age and sex, and the remaining control variables. The values of driver age and many of the other control variables are make-model-MY averages derived from the induced-exposure accident data file. This initial paradigm is applied to study fatality rates in principal rollovers of passenger cars, by curb weight and by track width.

Table 5-2 documents the Step 1 regression. The independent variables describing vehicle age (VEHAGE, BRANDNEW) and the calendar year (CY89, CY90, CY92, CY93) were defined in Section 3.1; State groups (STGP1, STGP2, STGP4, STGP5) in Section 5.2. Polk and fatality data were celled by State group, calendar year and model year (total of 195 cells). The fatality rate is computed in each cell and its logarithm (which tends to have more linear relationships with typical independent variables than does the accident rate itself) is the dependent variable. Since some cells contain more data than others, the regression is weighted by REGS, the number of vehicle registration years in a cell. Weighted linear regression is performed by the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) [30]. R^2 for this regression is a high .82.

The lower section of Table 5-2 shows that the Step 1 control variables have plausible, statistically significant relationships with the rollover fatality rate. VEHAGE (vehicle age) has a coefficient of -.048 ($t = -4.87$, $p < .01$). In other words, the fatality rate per million years decreases by 4.8 percent a year as a car gets older. However, BRANDNEW has a coefficient of +.295, indicating a much higher rollover rate for cars in their first year, when drivers are unfamiliar with them but also drive them extensively. State groups 1 and 2, which include many Northern States with relatively few young people and many urbanized States, have substantially lower rollover rates than "baseline" State group 3, while State group 5 (Southern and Southwestern States with many young people and large rural areas) has substantially higher rates. Calendar years 1989 and 1990 had slightly higher fatality rates than "baseline" 1991; 1992 and, to a lesser extent, 1993 had lower rates.

In preparation for the Step 2 regression, each **car registration year** is given a weight factor corresponding to the Step 1 regression coefficients. For example, consider a 2-year-old [model

TABLE 5-2

PASSENGER CARS: AGGREGATE LINEAR REGRESSION
OF ROLLOVER FATALITIES PER MILLION VEHICLE REGISTRATION YEARS

STEP 1: BY VEHICLE AGE, STATE GROUP AND CALENDAR YEAR

Dependent Variable: LOGROLL (logarithm of the rollover fatality rate)

Aggregation Method: by State Group, Calendar Year and Model Year

N of Observations: 195

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-10.77510640	-168.13	0.0001	0.06408743
VEHAGE	-0.04816670	-4.87	0.0001	0.00989475
BRANDNEW	0.29527256	4.29	0.0001	0.06875750
STGP1	-0.81764339	-15.36	0.0001	0.05324759
STGP2	-0.67394533	-12.60	0.0001	0.05349409
STGP4	-0.07088546	-1.23	0.2188	0.05744581
STGP5	0.48845370	7.70	0.0001	0.06346749
CY89	0.01348792	0.23	0.8181	0.05857405
CY90	0.05553943	1.00	0.3172	0.05537475
CY92	-0.09760682	-1.86	0.0651	0.05259870
CY93	-0.05293430	-1.01	0.3116	0.05216407

year 1987] car, registered in one of the States of State group 5, in calendar year 1989. Since the coefficients for VEHAGE, STGP5 and CY89 are -.048, .488 and .013 respectively, this registration will not be counted as 1 vehicle year in Step 2, but will count as

$$\exp[2 \times (-.048) + .488 + .013] = 1.499 \text{ vehicle years}$$

In other words, since rollover fatalities were more common in State group 5 and in 1989 than in most other places and times, the vehicle registration years are weighted upwards to equalize the fatality rate across State groups, calendar years and vehicle age. This adjustment procedure differs from the one used in Section 4.4. Instead of deflating the numerator, it inflates the denominator, and vice-versa. The rationale is that, given a choice of two variables to adjust with weight factors, it is preferable to adjust the less tangible of the two. In Chapter 4, induced-exposure crashes were less tangible than vehicle registration years. Here, the registration years are less tangible than the fatality counts.

In the Step 2 regression, the Polk data (with their weight factors) and the fatality data are initially celled by car group (CG), make-model (MM2), body style (BOD2) and model year (MY). Unlike the analysis in Section 4.4, the majority of these initial cells will have zero rollover fatalities or at most one or two. That is not enough for meaningful fatality rates in the cells. The rule-of-thumb for regression analyses of this type is a minimum of 5 **expected** fatalities per cell [30], p. 205. To avoid losing most of the data, it will be necessary to collapse many of the initial cells, or to aggregate at a higher level. An iterative procedure is used. The 4,329 fatal rollover crashes resulted in 4,681 fatalities, in 313,273,000 vehicle years. At that rate, it would take 334,600 vehicle years to produce an **expected** 5 rollover fatalities: that number of vehicle years will be the minimum accepted cell size for analyses of car rollovers. Any initial CG-MM2-BOD2-MY cell that accumulated more than 334,600 adjusted vehicle years during 1989-93 (such as the 1985 Chrysler 5th Avenue 4-door and many other relatively high-volume cars) is accepted and set aside for use in the analysis. All other cells are returned to a pool for the next iteration. That pool of Polk and fatality data is celled by CG, MM2 and BOD2 (but not by MY). Most cars with average or better volume accumulated 334,600 car years over 1989-93 when all model years are pooled together. Those cells are accepted and set aside; the remainder are returned to the pool. In the third iteration, the remaining data are celled by CG and MM2 (but not by BOD2 or MY); in the last, by CG only. The result is 347 data points for the regression, each containing at least 334,600 car years. Only relatively few low-volume or late-model car groups, such as Peugeot or Chrysler LHS cars were excluded from the analysis. For each data point, the weighted **average** value of the independent variables, such as CURBWT, YOUNGDRV, TWODOOR, etc., is used in the regression (weighted by the number of induced-exposure crashes or adjusted vehicle years, depending on whether that variable is derived from the induced-exposure file [e.g., YOUNGDRV] or directly from the Polk file [e.g, TWODOOR] - see Section 5.2). The dependent variable is the logarithm of the fatality rate in that cell (the actual fatality count divided by the adjusted exposure years). Although each cell is "expected" to have at least 5 rollover fatalities, some (especially some big cars) have zero actual fatalities. Those zeros are changed to 0.1 to allow calculation of the logarithm of the fatality rate. The regression is weighted by REGS, the adjusted number of vehicle registration years in a cell. In several preliminary analyses, SPDLIM55, WET and SNOW_ICE never had statistically significant coefficients. Those three variables are not used in any of the analyses documented in the rest of this chapter.

Table 5-3 documents the initial Step 2 regression of passenger car rollovers by curb weight. It is obvious that something went wrong with the regression. Curb weight has a nonsignificant coefficient of -.000061 (t = -.47). In other words, after "controlling" for driver age, sex, etc., fatal rollovers per million vehicle years decrease by only 0.61 percent for every 100 pound increase in curb weight. The effects of the control variables YOUNGDRV, OLDMAN and OLDWOMAN, are not intuitively reasonable. The coefficient for YOUNGDRV is +.184 - i.e., the fatality rate increases by 18.4 percent for every year that the driver is under 35. It is true that rollovers are a young-driver problem, but not to the extent of 18.4 percent a year: that implies a 17-year-old driver has 21 times the rollover risk as a 35-year-old driver. The coefficient for OLDMAN is a strongly negative -.139, when it should have been mildly positive or close to zero. The effect for OLDWOMAN ought to be fairly close to that for OLDMAN, but it is +.054.

This is another case of a regression going bad due to intercorrelation of certain independent variables: CURBWT with the three driver-age variables. In Chapter 3, CURBWT and YOUNGDRV were entered in the regression for each **individual** accident case, and they had a "safe" correlation coefficient of -.26. Now, the data are **aggregated** at the make-model-MY level, and the cell-average values of YOUNGDRV and CURBWT have correlation coefficient -.66. In other words, some big cars have young drivers and some small cars have old drivers, but almost all big make-models have, on the average, older drivers than small make-models. There is no simple "rule of thumb" for how large the intercorrelation coefficient may be before regressions go bad. The author has experienced regression analyses that succeeded despite substantially higher intercorrelation coefficients ([18], pp. 87-138). On other occasions, regressions went bad at an even lower level of intercorrelation (C. J. Kahane, *An Evaluation of Side Structure Improvements in Response to Federal Motor Vehicle Safety Standard 214*, Report No. DOT HS 806 314, NHTSA, 1982, pp. 274-280). While a coefficient of .66 does not guarantee either good or bad regressions, it produced a bad one here. The effect of CURBWT was mistakenly attributed to YOUNGDRV (by inflating the coefficient) and OLDMAN (by giving the coefficient the wrong sign).

All of the other independent variables, however, had the right sign or were close to zero. Rollover fatality risk was lower for female drivers and for station wagons, as it ought to be. It was higher for cars driven extensively at night, for convertibles and two-door cars, and for cars with ABS, consistent with earlier studies [18], pp. 218-220, [20], pp. 105-108. The "damage," at first glance, appears limited to CURBWT and the driver-age variables.

Table 5-4, which documents the regression of passenger car rollovers by **track width**, shows how unstable the coefficients are when there is an intercorrelation problem. It might be expected to produce the same distortions as the preceding regression, but it did not. The coefficient for track width is -.104, implying that each inch of reduced width increases fatality risk by 10.4 percent. That is very similar to the effect obtained in regression C2 of Table 3-2 (10.8 percent per inch). The coefficient for YOUNGDRV is +.128, which is higher than it ought to be, but not as extreme as the .184 in the preceding analysis: it implies that a 17-year-old driver has 9 times the rollover risk as a 35-year-old driver (almost believable). The most revealing symptom of a bad regression is the strongly negative coefficient for OLDMAN (it should have been positive or

TABLE 5-3

PASSENGER CARS: [FAILED] AGGREGATE LINEAR REGRESSION OF ROLLOVER FATALITIES PER MILLION VEHICLE REGISTRATION YEARS

STEP 2: BY **CURB WEIGHT**, attempting to control for driver age, sex and other vehicle and accident factors

Dependent Variable: LOGROLL (logarithm of the rollover fatality rate, calculated after adjusting the registrations by vehicle age, State group, and CY, based on the coefficients from the Step 1 regression)

Aggregation Method: by Car Group, Make-Model, Body Style and Model Year, with further aggregation across model years, body styles and/or make-models until a minimum cell size of 334,600 vehicle regestration years was reached

N of Observations: 347 (after all aggregations, cells that still had fewer than 334,600 vehicle registration years were deleted)

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-11.55647148	-13.91	0.0001	0.83098075
CURBWT	-0.00006100	-0.47	0.6415	0.00013089
YOUNGDRV	0.18448914	3.90	0.0001	0.04733230
OLDMAN	-0.13864693	-2.03	0.0431	0.06828963
OLDWOMAN	0.05410406	0.60	0.5494	0.09027714
FEMALE	-0.44370241	-0.59	0.5553	0.75144305
NITE	1.03248928	0.59	0.5544	1.74487598
RURAL	-0.08535443	-0.05	0.9583	1.63051507
CONVRTBL	0.37365554	0.88	0.3781	0.42334816
TWODOOR	0.20193484	1.79	0.0739	0.11263657
STAWAGON	-0.26370191	-1.42	0.1553	0.18514781
ABS4	0.38231859	1.63	0.1048	0.23509743

TABLE 5-4

PASSENGER CARS: [FAILED] AGGREGATE LINEAR REGRESSION OF ROLLOVER FATALITIES PER MILLION VEHICLE REGISTRATION YEARS

STEP 2: BY **TRACK WIDTH**, attempting to control for driver age, sex and other vehicle and accident factors

Dependent Variable:	LOGROLL (logarithm of the rollover fatality rate, calculated after adjusting the registrations by vehicle age, State group, and CY, based on the coefficients from the Step 1 regression)
Aggregation Method:	by Car Group, Make-Model, Body Style and Model Year, with further aggregation across model years, body styles and/or make-models until a minimum cell size of 334,600 vehicle regestration years was reached
N of Observations:	347 (after all aggregations, cells that still had fewer than 334,600 vehicle registration years were deleted)
Weighting Factor:	REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-5.102039528	-2.96	0.0033	1.72585822
TRAKWDTH	-0.10372829	-4.20	0.0001	0.0246840
YOUNGDRV	0.128433533	3.06	0.0024	0.04202929
OLDMAN	-0.095146798	-1.46	0.1452	0.06516441
OLDWOMAN	-0.011949835	-0.14	0.8915	0.08751971
FEMALE	-1.239292961	-1.66	0.0972	0.74517998
NITE	1.062467494	0.64	0.5256	1.67216601
RURAL	0.027467804	0.02	0.9861	1.57937739
CONVRTBL	0.346084009	0.85	0.3971	0.40820934
TWODOOR	0.297684069	2.88	0.0042	0.10333952
STAWAGON	-0.342951248	-1.90	0.0583	0.18049640
ABS4	0.224189947	0.97	0.3349	0.23215257

close to zero). Also, the coefficient for FEMALE, -1.24, is stronger than it should be: it implies female drivers have 71 percent lower rollover fatality risk than males (1 - exp(-1.24) = .71). Thus, Table 5-3 shows results that are clearly out of line, while this regression produced some coefficients that almost "look right." The initial paradigm for the analysis can simply not be relied on to produce correct coefficients for vehicle size, driver age or sex.

5.5 Exogenous coefficients for driver age and sex

If the "right" coefficients for driver age and sex were known, and if those coefficients could be imposed on the regression analyses, they should, in combination with the other control variables, produce valid effects for the vehicle size variable. A procedure was developed in Section 4.6 to "force" various coefficients for the driver-age variables onto the regression of induced-exposure crashes per 1000 vehicle years; it was used to test the sensitivity of the weight effect to changes in the age coefficients. A similar procedure can be used to apply the "right" age and sex coefficients to the analysis of fatalities per million vehicle years.

The earlier analyses of fatalities per 1000 induced-exposure crashes, and induced-exposure crashes per 1000 vehicle years are the source of the coefficients. Although those analyses had shortcomings (biases, insufficient sample sizes) for accurately estimating the [relatively weak] **weight**-safety relationship, they may be relied upon for a sufficiently accurate estimate of the [much stronger] **age**-safety relationship.

The appropriate driver-age coefficients are the **sums** of the corresponding coefficients in the Chapter 3 and Chapter 4 regressions. For example, Table 3-1 estimates a coefficient of .0770 for YOUNGDRV - i.e., the logarithm of the rate of rollover fatalities (F) per induced-exposure crash (IE) increases by .0770 for each year that the driver's age (A) is under 35:

$$\log (F_{A-1}/IE_{A-1}) - \log (F_A/IE_A) = +.0770$$

Table 4-2 estimates a coefficient of .0278 for YOUNGDRV - i.e., the logarithm of the rate of induced-exposure crashes per car registration year (CRY) increases by .0278 for each year that the driver is under 35:

$$\log (IE_{A-1}/CRY_{A-1}) - \log (IE_A/CRY_A) = +.0278$$

The coefficient of YOUNGDRV in the analysis of fatalities per car registration year - i.e., the net effect on the logarithm of the rate of rollover fatalities per car registration year is:

$$\begin{gathered}\log (F_{A-1}/CRY_{A-1}) - \log (F_A/CRY_A) = \\ \log [(F_{A-1}/IE_{A-1})(IE_{A-1}/CRY_{A-1})] - \log [(F_A/IE_A)(IE_A/CRY_A)] = \\ [\log (F_{A-1}/IE_{A-1}) + \log (IE_{A-1}/CRY_{A-1})] - [\log (F_A/IE_A) + \log (IE_A/CRY_A)] = \\ [\log (F_{A-1}/IE_{A-1}) - \log (F_A/IE_A)] + [\log (IE_{A-1}/CRY_{A-1}) - \log (IE_A/CRY_A)] = \\ .0770 + .0278 = .1048\end{gathered}$$

The effects of OLDMAN, OLDWOMAN and FEMALE are likewise the sums of their coefficients in the Chapter 3 and 4 analyses. The top section of Table 5-5 lists the Chapter 3 coefficients, for passenger cars and light trucks, for the six principal types of fatal crashes. The last two lines of Table 5-5 list the Chapter 4 coefficients.

The procedure for regression analyses with exogenous coefficients for driver age and sex is the following. The Step 1 regression, by vehicle age, State group and calendar year, remains unchanged from the preceding section (e.g., the coefficients in Table 5-2 are still used for passenger car rollovers). As before, each **car registration year** is given a weight factor corresponding to the Step 1 regression coefficients, adjusting the fatality rates for the Step 1 control variables. Also unchanged, an iterative procedure is applied to cell the data, by CG, MM2, BOD2 and MY, if possible, or at a higher level of aggregation, if necessary, to produce cells with at least 5 expected fatalities, and the weighted average value of each independent variable, including YOUNGDRV, OLDMAN, OLDWOMAN and FEMALE, is calculated for each cell.

Next, the car registration years are adjusted a second time to "force" the coefficients for YOUNGDRV, OLDMAN, OLDWOMAN and FEMALE, as shown in Table 5-5, into the analysis. For example, in the analysis of passenger car rollovers by curb weight, suppose that 1986 Mustangs accumulated 1,000,000 vehicle registration years (after the Step 1 adjustments) and that the drivers of 1986 Mustangs (on the induced-exposure accident file) have average values of 8.5 for YOUNGDRV, 1.0 for OLDMAN and 0.5 for OLDWOMAN and 0.3 for FEMALE. These 1,000,000 car years would henceforth be counted as

$$10^6 \text{ x } \exp[(.0770+.0278)\text{x}8.5 + (.0263-.0374)\text{x}1.0 + (.0566-.0397)\text{x}0.5 + (-.7580+.0301)\text{x}0.3]$$
$$= 1{,}000{,}000 \text{ x } \exp[.1048\text{x}8.5 - .0111\text{x}1.0 + .0169\text{x}0.5 - .7279\text{x}0.3]$$
$$= 1{,}953{,}807 \text{ car years}$$

Finally, the regression, with the twice-adjusted registration data, is performed with the remaining independent variables: in this case, CURBWT, NITE, RURAL, CONVRTBL, TWODOOR, STAWAGON and ABS4. The regression is weighted by REGS, the Step-1-adjusted number of vehicle registration years in a cell.

5.6 Discussion of the vehicle-weight and driver-age coefficients

The numbers in Table 5-5 help put the relative importance of vehicle-weight effects and driver-age effects in perspective. It has been stated in this report that the weight-safety relationship is "weak" relative to the age-safety relationship. If so, it might be expected that modest errors in calibrating the age-safety coefficients could seriously distort the accuracy of the weight-safety coefficient. That impression may have been strengthened by the regression in Table 5-3, where large errors in the age-safety coefficients did, in fact, distort the weight-safety coefficient for rollover crashes. Nevertheless, that is largely a false impression. Even though the age-safety relationship is strong, it is quite **nonlinear** and, except in rollovers, it is **not monotone**, but U-shaped (see Figure 1-1). In other words, the strong tendency of young drivers to have more fatal involvements for each year that they are under 35 is more or less canceled out, except in rollovers, by the strong tendency of older drivers to have more fatal involvements for each year

TABLE 5-5

REGRESSION COEFFICIENTS FOR VARIABLES THAT DEFINE DRIVER AGE AND SEX
PASSENGER CARS AND LIGHT TRUCKS

Type of Crash / Vehicle Type	Regression Coefficients YOUNGDRV	OLDMAN	OLDWOMAN	FEMALE
FATALITIES PER 1000 INDUCED-EXPOSURE CRASHES				
Rollover, by curb weight				
Cars (Table 3-2, run C1)	+ .0770	+ .0263	+ .0566	- .7580
Light trucks (3-5, T1)	+ .0783	+ .0471	+ .0751	- .2434
Rollover, by track width				
Cars (3-2, C2)	+ .0756	+ .0282	+ .0582	- .7700
Light trucks (3-5, T2)	+ .0758	+ .0472	+ .0763	- .2584
Hit object				
Cars (3-2, C9)	+ .0768	+ .0702	+ .0900	- .8857
Light trucks (3-5, T4)	+ .0644	+ .0631	+ .0724	- .5501
Ped, bike, motorcycle				
Cars (3-2, C11)	+ .0350	+ .0363	+ .0571	- .5671
Light trucks (3-5, T5)	+ .0312	+ .0266	+ .0333	- .3424
Hit big truck				
Cars (3-2, C12)	+ .0494	+ .0872	+ .0966	- .5559
Light trucks (3-5, T6)	+ .0193	+ .0846	+ .0948	- .3351
Hit car				
Cars (3-2, C13)	+ .0397	+ .0717	+ .0703	- .4249
Light trucks (3-5, T7)	+ .0367	+ .0312	+ .0368	- .3317
Hit light truck				
Cars (3-2, C14)	+ .0423	+ .0854	+ .0849	- .4136
Light trucks (3-5, T8)	+ .0417	+ .0551	+ .0609	- .0305
INDUCED-EXPOSURE CRASHES PER 1000 VEHICLE YEARS				
Cars (4-2)	+ .0278	- .0374	- .0397	+ .0301
Light trucks (4-5)	+ .0082	- .0743	- .0935	+ .1451

that they are over 45-50. The bias against light cars, that have an abundance of young drivers, is offset by a similar bias against heavy cars, that have an abundance of old drivers. Even though the age-safety relationship can be strong from one year to the next, the net effect across all age groups is substantially weaker.

The coefficients from Table 5-5 illustrate how the driver-age effects vary by type of crash. In rollovers (by curb weight), the effect for YOUNGDRV is .0770 + .0278 = .1048. The effects are .0263 - .0374 = -.0111 for OLDMAN and .0566 - .0397 = +.0169 for OLDWOMAN. In other words, rollover risk decreases by 10 percent a year from age 16 to 35 and remains almost constant thereafter. In rollovers, there is a substantial bias against lighter cars in the unadjusted data. In collisions of a car with a light truck, the net coefficients are +.701 for YOUNGDRV, +.480 for OLDMAN and +.452 for OLDWOMAN. Thus, the driver-age effect is U-shaped and the net effect of adjusting the data for driver age will be small. Collisions with big trucks and cars also have U-shaped driver-age effect. Collisions with fixed objects and pedestrians have driver-age effects in between those seen in rollovers and those seen in the multivehicle collisions.

CHAPTER 6

FATALITIES PER MILLION VEHICLE YEARS IN THE UNITED STATES FINDINGS AND SENSITIVITY TESTS

6.1 Regressions on the size of the "case" passenger car

Two-step regression analyses, based on the methods developed in Chapter 5, were performed for each of the major subgroups of fatal crashes:

- o Principal rollovers, by curb weight
- o Principal rollovers, by track width
- o Collisions with objects, by curb weight
- o Collisions with pedestrians, bicycles, motorcycles, by weight of the car
- o Collisions with big trucks, by curb weight of the car
- o Collisions with passenger cars, by curb weight of the "case" car
- o Collisions with light trucks, by curb weight of the car

In each of these seven analyses, the measure of risk (dependent variable) is the total number of fatalities, including occupants of the case vehicles, occupants of other vehicles, and pedestrians, per million vehicle years.

Table 6-1 documents the regression of principal rollovers of passenger cars, by curb weight, with exogenous coefficients for driver age and sex. The regression coefficient for curb weight is -.000458. The standard error (standard deviation) of the coefficient is .000071. Thus, the effect is statistically significant at the .01 level (t = -.000458/.000071 = -6.45). In other words, a 100 pound weight increase is associated with a 4.6 percent reduction in rollover fatalities, while a 100 pound weight reduction is associated with a 4.6 percent increase in fatalities. Thus, the rollover fatality rate per million car years is 59 percent lower in a 4000-pound car than in a 2000-pound car, after controlling for driver age, sex and other factors. These effects seem intuitively reasonable.

The exogenous coefficients for driver age and sex, which were derived from earlier analyses (Table 5-5) are quite plausible. The coefficient for YOUNGDRV is .1048: rollover risk increases by 10.5 percent for each year that a driver is under 35. A 17-year-old driver has 6 times the rollover risk as a 35-year-old driver - a steep, but believable increase. The coefficients for OLDMAN and OLDWOMAN are both close to zero: the reduced mileage of older drivers more or less offsets their increased vulnerability to injury and tendency to lose control and run off the road. The coefficient for FEMALE, -.7279, implies that female drivers have 52 percent fewer fatal rollover crashes, per million years, than male drivers.

The coefficient of +3.98 for NITE requires an explanation. Although in the right direction (rollovers often occur at night), it is surprisingly strong. In this regression, NITE is entered as an **average** for all crashes involving a particular make-model. Make-models are driven a lot at night, such as Pontiac Firebird have values of NITE as high as .30, while vehicles that are driven

TABLE 6-1

PASSENGER CARS: AGGREGATE LINEAR REGRESSION
OF ROLLOVER FATALITIES PER MILLION VEHICLE REGISTRATION YEARS

STEP 2: BY **CURB WEIGHT**, controlling for driver age and sex
(exogenous coefficients) and other vehicle and accident factors

Dependent Variable: LOGROLL (logarithm of the rollover fatality rate, calculated after adjusting the registrations by vehicle age, State group, and CY, based on the coefficients from the Step 1 regression **and** by YOUNGDRV, OLDMAN, OLDWOMAN and FEMALE, based on the coefficients in Table 5-5)

Aggregation Method: by Car Group, Make-Model, Body Style and Model Year, with further aggregation across model years, body styles and/or make-models until a minimum cell size of 334,600 vehicle registration years was reached

N of Observations: 347 (after all aggregations, cells that still had fewer than 334,600 vehicle registration years were deleted)

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-10.63841102	-26.62	0.0001	0.39957337
CURBWT	**-0.00045822**	**-6.45**	**0.0001**	**0.00007099**
YOUNGDRV	*0.1048*	*Derived*		
OLDMAN	*-0.0111*		*From*	
OLDWOMAN	*0.0169*		*Table*	
FEMALE	-0.7279			5-5
NITE	3.98361934	3.64	0.0003	1.09583582
RURAL	-0.49120583	-0.31	0.7596	1.60389472
CONVRTBL	0.63662206	1.50	0.1347	0.42456448
TWODOOR	0.41758102	4.92	0.0001	0.08480939
STAWAGON	-0.23367367	-1.40	0.1619	0.16670005
ABS4	0.37070953	1.67	0.0960	0.22207666

relatively more during the day, such as Buick Park Avenue, have values of NITE closer to .10. The coefficient says that make-models with NITE = .30 have 2.2 times the rollover rate of make-models with NITE = .10, *ceteris paribus*. The coefficient for RURAL is not statistically significant. That is also surprising, since rollovers ought to be more common in rural areas. But the Step 1 regression controlled for State group: the data have already been adjusted for the highly significant effect that the generally rural States in group 5 have high rollover rates. Thus, RURAL on Step 2 is a "second-order" correction, identifying vehicles that are driven in the most rural areas of a given State, but not differentiating whether a vehicle is registered in a rural or an urbanized State. Its effect in the regressions can be unpredictable.

The four remaining control variables all had effects in the right direction and magnitude. Rollover fatality risk increased substantially in convertibles and, to lesser extent, two-door cars, but risk was lower in station wagons. Cars equipped with ABS had a higher rollover rate. R^2 for this regression is .34, which is very high, considering that the effects of the most important determinants of fatality risk (driver age, sex, State group) have already been "leached out" prior to Step 2.

Table 6-1 illustrates the importance of adjusting the data for the control variables. In the unadjusted data (Figure 5-1), the logarithm of the rollover fatality rate decreased from -10.6 at 1800 pounds to -12.4 at 4100 pounds: an exceedingly strong slope of -.000783 per pound. But after controlling for driver age, sex and other confounding variables, the residual effect associated with vehicle weight drops to a more realistic -.000458 per pound.

The observed effect, a 4.6 percent fatality increase per 100 pound weight reduction, is slightly stronger than the result in Kahane's 1990 study of rollovers [17], which amounted to a 3.5 percent fatality increase per 100 pound reduction. The results, however, are not directly comparable, since the present analysis is limited to principal rollovers, whereas the earlier study included collision-induced rollovers, where the size-safety effect is much weaker (see Table 3-2, for example).

The principal results of the seven regression analyses for passenger car "case" vehicles, including the preceding one, are documented in Table 6-2. The preceding analysis is PC1, the first one listed in Table 6-2. The first column of Table 6-2 indicates the Run Number (sequentially assigned to allow easy reference to the various analyses), the type of fatal crashes analyzed, and their codes, as defined in Table 2-1. The third column shows the measure of car size (curb weight or track width). The next three columns indicate the fatality sample size, the minimum number of vehicle years per cell in the Step 2 regression, and the number of cells (data points) in the Step 2 regression. The next column, in bold type, is the main result: the estimated **percentage** change in fatalities associated with a **100 pound reduction of curb weight** (or a 1 inch reduction of track width). It is followed by the standard deviation of the estimated change, derived from the "standard error of the regression coefficient." The last column displays the t-value for the regression coefficient of the car-size measure - i.e., the coefficient divided by its standard deviation. The t-value has to exceed 1.65 for statistical significance at the one-sided .05 level, 1.96 for significance at the two-sided .05 level and 2.58 for significance at the two-sided .01 level.

TABLE 6-2

PASSENGER CARS: REGRESSIONS OF FATALITY RISK PER MILLION VEHICLE YEARS, BY "CASE" VEHICLE SIZE

MEASURE OF RISK: fatalities in the crash per million vehicle years
MEASURE OF SIZE: curb weight or track width of the passenger car "case" vehicle
CONTROLLING FOR: driver age & sex, car body style & equipment, road & accident conditions, etc.

Run No.:	**Crash Type (Codes)**	**Measure of Size (Case Car)**	**N of Fatals**	**Min Cell Size**	**N of Cells**	**Effect per 100 Pound or 1 Inch REDUCTION (%)**	**One Std Dev**	**t value**
PC1:	principal rollover (11)	WEIGHT	4,681	334,600	347	**+ 4.58 per 100**	.71	6.45
PC1a:	principal rollover (11)	TRACK WIDTH	4,681	334,600	347	**+13.37 per inch**	1.57	8.53
PC2:	hit object (12-17, 81)	WEIGHT	18,806	83,300	1224	**+ 1.12 per 100**	.30	3.77
PC3:	ped-bike-motorcycle (21-22)	WEIGHT	9,742	160,800	850	**- .46 per 100**	.26	1.74
PC4	hit big truck (31-39)	WEIGHT	6,005	260,800	805	**+ 1.40 per 100**	.47	2.95
PC5	hit another car (41-59)	WEIGHT	23,412	66,900	1350	**- .31 per 100**	.24	1.29
PC6	hit light truck (61-79)	WEIGHT	11,699	133,900	1003	**+ 2.63 per 100**	.34	7.68

Rollover stability is believed to have an even stronger relationship with track width than with curb weight (see Section 1.2). Analysis PC1a calibrates rollover fatality risk by track width, and it estimates that fatality risk increases by a very substantial 13.37 percent for every inch of reduction in track width. Since the t-value for the track-width coefficient is 8.53, versus 6.45 for curb weight in PC1, these analyses support the hypothesis that track width has the stronger relationship with rollover risk. Analysis PC1a duplicates PC1 for Step 1 and uses the same cells on Step 2. However, the adjustments for driver age and sex are slightly different, as shown in Table 5-5. In the Step 2 regression (where TRAKWDTH, instead of CURBWT, is the key independent variable), the coefficients for NITE, RURAL, etc. are nearly the same in both cases.

Analysis PC2 addresses collisions with objects, primarily fixed objects. It involved running new Step 1 and Step 2 regressions, with the object-collision fatality rate as the dependent variable. The Step 1 regression associated with PC2 produced coefficients for vehicle age, State group and calendar year that were generally similar to those in PC1 and PC1a (although State groups 1 and 2 are especially low in rollovers, while State group 4 is relatively high in collisions with objects). The large sample of 18,806 fatalities allows the use of 1224 cells in Step 2, and yields precise estimates for the coefficients: the standard deviation of the size-safety effect is .30 here, whereas it was .71 in PC1, the rollover analysis.

The Step 2 regression uses the exogenous coefficients for driver age and sex appropriate for collisions with objects (see Table 5-5 and the discussion in Section 5.6). The effect of driver age is different in fixed-object impacts and rollovers. The likelihood of a fatal rollover decreases strongly from age 18 to 35 and stays about level beyond age 35. That created a bias against lighter cars (which have many young drivers) in the unadjusted data. In fixed-object crashes, risk drops from age 18 to 35, levels off, but then starts to rise again after age 45-50. Light cars have many young drivers and heavy cars have many old drivers: both high-risk groups. So there is less bias against lighter cars in the unadjusted data.

This regression estimated that a 100 pound weight reduction results in a 1.12 percent increase in fatality risk; the effect is significant at the .01 level ($t = 3.77$). This regression, unlike the preceding ones, produced coefficients that look "just right" for NITE (+2.86) and RURAL (+2.12). It associated a 15 percent reduction of fatality risk with air bags (the majority of these collisions are frontal, so AIRBAG is added as a control variable), and a nonsignificant increase with ABS.

The observed 1.12 percent fatality increase per 100 pound weight reduction is much weaker than the 4.58 percent effect for rollovers in analysis PC1 - consistent with intuition that the size-safety effect is especially strong in principal rollovers. It is very close to the 0.9 percent fatality effect on "single-vehicle nonrollover crashes" found by Klein *et al.* in NHTSA's 1991 size-safety study [23]. The results, however, are not directly comparable, since the present analysis (fatalities per million years) incorporates crash-proneness as well as crashworthiness effects, while the earlier one (fatalities per 100 crashes) only addressed crashworthiness effects.

PC3 estimates that the fatality risk of pedestrians, bicyclists and motorcyclists is **reduced** by 0.46 percent for every 100 pound reduction in the weight of cars - an effect in the opposite direction of the preceding analyses. The fatality reduction is statistically significant at the one-sided .05 level (t = 1.74). The direction of the effect is consistent with the 2.4 percent reduction found by Mengert and Borener [25]. The results, however, are not directly comparable because Mengert and Borener did not control for driver age, sex, State, or other variables. But the consistent trend is that a reduction in car weight is beneficial to road users that are smaller than cars. As might be expected, in the Step 1 regression, the coefficient for State group 5 (extensively rural Southern States) was much less for this type of crash than for rollovers and impacts with objects. Also consistent with intuition: the YOUNGDRV and FEMALE effects were not as strong as in the preceding analyses, RURAL was nonsignificant in the Step 2 regression, and a significant 24 percent fatality reduction was associated with ABS [20], pp. 64-68.

Fatality risk in collisions between cars and big trucks (over 10,000 pounds GVW) is modeled in PC4. Of course, almost all the fatalities are car occupants. Table 6-2 shows that each 100 pound reduction in the weight of the cars increases fatality risk by 1.40 percent, significant at the .01 level (t = 2.95). This effect is quite similar to the 1.12 percent increase in collisions with objects (the other mode involving something much bigger and stronger than a car). This Step 1 regression had substantially larger calendar-year effects than the others: the number of big trucks on the road has cyclical patterns tied to the economy. The coefficients for OLDMAN and OLDWOMAN are more strongly positive (i.e., more fatalities for older drivers) here than for any other type of crash. In fact, older car drivers have even greater risk of fatal involvement with a big truck than young car drivers. Thus, the unadjusted data are actually biased in favor of lighter cars. Initial Step 2 regressions produced some too-strong or even wrong-sign coefficients for car body style, air bags and ABS. The best results were obtained by using only CURBWT, NITE and RURAL. As might be expected, NITE was nonsignificant, and RURAL was associated with higher fatality risk.

Figures 5-5 and 5-5a showed little or no overall weight-safety effect in the unadjusted data on collisions between two passenger cars. The heavier car's fatality reducing benefit for its own occupants is almost perfectly offset by the increased risk to the occupants of the other car. Since two-car collisions are not particularly a "young-driver" or an "old-driver" problem, controlling for driver age and sex does not change the results much. Indeed, PC5, even though it has the largest sample size, is the only analysis in Table 6-2 that does not show a significant effect for curb weight (t = 1.29). The observed effect is a 0.31 percent reduction in fatalities per 100 pound reduction in the weight of the **case** car. If fatality risk decreases by 0.31 percent when the case car is reduced by 100 pounds and the other car is unchanged, it would decrease by double this amount, 0.62 percent, when **both** cars are reduced by 100 pounds.

The present result is consistent with two earlier DOT analyses of **fatality** risk: Klein *et al.* found no significant effect on fatality risk per 100 Texas two-car crashes when both cars were reduced in weight [23]; Mengert and Borener found a 0.8 percent reduction in fatality risk when both cars are reduced by 100 pounds [25]. Neither study is fully comparable to the present analysis: the first studied only crashworthiness effects, the second did not use control variables. These three studies of fatalities differ with analyses of **nonfatal injuries**, which have usually shown significantly lower injury rates in collisions of two big cars than two small cars [23], [24]. Apparently, the weight-safety relationship is different at the nonfatal level.

The Step 1 and Step 2 regressions for car-to-car crashes show few extreme or unusual effects. State group 2, which includes States such as New York and Pennsylvania where cars greatly outnumber light trucks, achieves its most positive coefficient here. NITE and RURAL have moderately positive effects (1.76 and 1.44). Air bags and ABS perhaps show more benefits than they ought to, possibly due to intercorrelation with the body style variables, which ought to be having little or no effect here, but sometimes have significant negative coefficients. The Step 2 regression was rerun without AIRBAG, ABS4 and/or the body style variables, each time producing a nonsignificant coefficient for CURBWT.

PC6 shows a strong weight-safety effect in collisions between cars and light trucks. Each 100-pound reduction in the weight of the cars, while the light trucks stay unchanged, increases fatalities by 2.63 percent. The effect is significant at the .01 level (t = 7.68). This strong trend was already obvious in the unadjusted data. Since 80 percent of the fatalities are car occupants, the increased risk for the car occupants, when car weight is reduced, far exceeds the benefits for the occupants of the light trucks. The effect here is twice as strong as in collisions with objects or heavy trucks, because momentum in addition to crashworthiness factors work against the light car. The effects of all the independent variables except CURBWT, in the Step 1 and Step 2 regressions, were quite similar to those for car-to-car crashes (except that car-heavy State groups 1 and 2 had lower rates of car-truck collisions).

While there are some individual differences between the results of this chapter and those of Chapter 3 (which were based on fatalities per 1000 induced-exposure crashes), the general trend of the results (as expressed by their rank order and average) is quite similar for both chapters:

	Effect on Fatalities per 100 Pound Reduction (%)			
	Chapter 5		Chapter 3	
	Run No.	Effect	Run No.	Effect
Principal rollover	(PC1)	+4.58	(C1)	+2.48
Hit object	(PC2)	+1.12	(C9)	+1.91
Ped-bike-motorcycle	(PC3)	- .46	(C11)	-1.00
Hit big truck	(PC4)	+1.40	(C12)	+2.62
Hit passenger car	(PC5)	- .31	(C13)	+ .78
Hit light truck	(PC6)	+2.63	(C14)	+3.17

The results of this chapter are much more reliable. In addition to possible biases in the induced-exposure method, the Chapter 3 results are less precise since they are based on data from just 11 States (about ¼ the fatality sample). In general, the individual Chapter 3 results have wide enough confidence bounds that the differences between them and the Chapter 5 estimates could be due to sampling error, alone.

6.2 Regressions on the size of the "case" light truck

Seven two-step regression analyses, with light trucks as "case" vehicles, were performed for the same crash modes as with passenger cars. The measure of risk (dependent variable) is, as before, the total number of fatalities, including occupants of the case vehicles, occupants of other vehicles, and pedestrians, per million vehicle years.

The procedure for analyzing light trucks is very similar to that for passenger cars (see Chapter 5). Step 1 is identical. FARS and POLK data for light trucks are celled by State group, calendar year and model year, and a weighted linear regression on the logarithm of the fatality rate is performed. Table 6-3 documents the Step 1 regression for rollover crashes of light trucks. The control variables are the same as in Table 5-2, the analogous regression for passenger cars. The coefficients are also quite similar (however, the intercept is less negative for light trucks because they have a higher rollover rate). The strongly significant coefficients for the State groups illustrate the importance of controlling for those variables.

The preparation for Step 2 is slightly simpler for light trucks. Whereas cars are initially celled by CG, MM2, BOD2 and MY, the body style variable does not exist for light trucks, and they are celled by CG, MM2 and MY, only. The iterative procedure to achieve cells comprising enough vehicle years to have 5 expected fatalities (130,700 vehicle years in the case of light truck rollovers) is performed just three times instead of four, because the BOD2 variable does not exist here. Adjustment of the registration data for the exogenous effects of driver age and sex variables is the same as for cars. The potential control variables for the Step 2 regression are NITE, RURAL, SUV, VAN, AWD, ABS2 and ABS4. However, since pedestrian crashes are the only type where light-truck ABS has been shown to affect fatality risk significantly [21], the ABS variables are entered only in the analysis of pedestrian crashes.

Table 6-4 presents the Step 2 regression of rollover fatalities by curb weight, which was based on 5,030 fatalities in 367 cells. The regression coefficient for curb weight is -.000081. In other words, a 100 pound weight reduction is associated with a 0.8 percent increase in fatalities. This effect is not statistically significant (t = -1.11). This result is quite a contrast to cars, where rollovers increased by 4.6 percent per 100 pound weight reduction. As described in Section 1.2, the relationship between vehicle mass and rollover risk should be quite different in cars and trucks. In either case, mass has relatively little intrinsic relationship to rollover stability. But in cars, greater mass has historically been synonymous with greater width at a relatively constant height - thus, substantially improving static stability. In trucks, greater mass does not necessarily mean greater width, or it might mean greater width **and** height - in either case, there is little change in static stability.

Each of the control variables has plausible coefficients. The exogenous effects for YOUNGDRV, OLDMAN and OLDWOMAN are about the same as for cars (Table 6-1). FEMALE has a negative coefficient (-.098), but not nearly as strong as for cars (-.728): there is less difference, in both mileage and intensity, between male and female truck drivers than between male and female car drivers. The coefficients for NITE (+2.89) and RURAL (+2.27) seem correct for rollover crashes, which are substantially more common at night, and on rural roads. Relative to a "baseline" rear-wheel-drive pickup, a rear-wheel-drive SUV has 15 percent

TABLE 6-3

LIGHT TRUCKS: AGGREGATE LINEAR REGRESSION
OF ROLLOVER FATALITIES PER MILLION VEHICLE REGISTRATION YEARS

STEP 1: BY VEHICLE AGE, STATE GROUP AND CALENDAR YEAR

Dependent Variable: LOGROLL (logarithm of the rollover fatality rate)

Aggregation Method: by State Group, Calendar Year and Model Year

N of Observations: 190

Weighting Factor: REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-10.01976152	-160.68	0.0001	0.06235999
VEHAGE	-0.02741418	-2.77	0.0062	0.00989825
BRANDNEW	0.19645396	2.98	0.0033	0.06602989
STGP1	-0.85791658	-16.21	0.0001	0.05292187
STGP2	-0.68543109	-12.86	0.0001	0.05328930
STGP4	0.13910573	2.56	0.0114	0.05438667
STGP5	0.47063266	8.10	0.0001	0.05807182
CY89	0.18934870	3.17	0.0018	0.05964290
CY90	0.07596916	1.36	0.1763	0.05595212
CY92	-0.11779143	-2.24	0.0260	0.05248068
CY93	-0.08762190	-1.70	0.0909	0.05154121

TABLE 6-4

LIGHT TRUCKS: AGGREGATE LINEAR REGRESSION
OF ROLLOVER FATALITIES PER MILLION VEHICLE REGISTRATION YEARS

STEP 2: BY **CURB WEIGHT**, controlling for driver age and sex
(exogenous coefficients) and other vehicle and accident factors

Dependent Variable:	LOGROLL (logarithm of the rollover fatality rate, calculated after adjusting the registrations by vehicle age, State group, and CY, based on the coefficients from the Step 1 regression **and** by YOUNGDRV, OLDMAN, OLDWOMAN and FEMALE, based on the coefficients in Table 5-5)
Aggregation Method:	by Light Truck Group, Make-Model, and Model Year, with further aggregation across model years, and/or make-models until a minimum cell size of 130,700 vehicle registration years was reached
N of Observations:	367 (after all aggregations, cells that still had fewer than 130,700 vehicle registration years were deleted)
Weighting Factor:	REGS (N of vehicle registration years)

REGRESSION COEFFICIENTS

Independent Variable	Regression Coefficient	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-11.31061894	-25.51	0.0001	0.44338456
CURBWT	**-0.00008066**	**-1.11**	**0.2683**	**0.00007275**
YOUNGDRV	*0.0865*	*Derived*		
OLDMAN	*-0.0272*		*From*	
OLDWOMAN	*-0.0184*		*Table*	
FEMALE	*-0.0983*			*5-5*
NITE	2.88770502	2.17	0.0310	1.33368887
RURAL	2.27123290	2.06	0.0399	1.10153235
SUV	0.13617566	1.21	0.2272	0.11257701
VAN	-0.46746333	-4.55	0.0001	0.10277582
AWD	0.40541071	3.80	0.0002	0.10671587

higher rollover risk, and a van, 37 percent lower. Four-wheel-drive vehicles have 50 percent higher rollover risk than comparable two-wheel-drive models (reflecting the location and manner that those vehicles are driven, and also their higher centers of gravity).

The results of the seven light-truck analyses, including the preceding one (LT1), are summarized in Table 6-5. LT1a calibrates rollover fatality risk by track width, and it estimates that fatality risk increases by 2.46 percent for every inch of reduction in the track width of light trucks. Unlike the weight-rollover relationship, this is a statistically significant effect at the .01 level (t = 2.81). Nevertheless, it is just a small effect in comparison to the 13.37 percent increase seen in passenger cars. Big, wide light trucks, unlike cars, are often tall or stand high off the ground, and they are not necessarily more stable than smaller make-models. The effects of the control variables are fairly similar in LT1 and LT1a.

LT2 estimates the effect of curb weight in collisions of light trucks with objects. Each 100 pound reduction in weight is associated with a 1.44 percent increase in fatality risk, significant at the .01 level (t = 3.33). In these crashes, where mass acts more directly by increasing the strength and space of the vehicle structure, rather than indirectly through its correlation with the rollover stability factor, there are similar effects in light trucks and cars (1.12 percent). In fact, the effect in light trucks may be a little stronger, because the really large light trucks may have enough momentum or height to knock down or ride over some of the objects. The coefficients of the control variables in the regressions are similar for rollovers and object-collisions, except that SUV and AWD, which had positive coefficients for rollovers, now have small or negative coefficients (when sport utility vehicles with four-wheel-drive run off the road, they are prone to roll over before they reach any fixed object).

Figure 5-9 suggested that the larger light trucks have higher rates of fatal involvements with pedestrians, bicyclists and motorcyclists. LT3 confirms that trend, and it estimates that a 100 pound weight reduction for light trucks is associated with a 2.03 percent reduction in fatalities for those road users, statistically significant at the .01 level (t = 5.13). The observed effect on pedestrian fatalities is in the same direction, but notably stronger than for passenger cars (0.46 percent per 100 pounds). It is not clear from these data **why** the larger trucks have a problem: whether the drivers have more difficulty seeing and/or avoiding pedestrians, or the tall, aggressive vehicle structure is more lethal, given a crash. In this analysis, as might be expected, RURAL, AWD, STGP4 and STGP5 (all associated with rural crashes) are substantially less positive or more negative than in other crash modes. ABS was associated with reductions in pedestrian fatalities.

LT4 estimates that every 100 pound weight reduction in light trucks increases, by 2.63 percent, the fatality rate in collisions with big trucks (over 10,000 pounds GVW). This weight-safety effect is statistically significant at the .01 level (t = 4.18) and, as was the case in collisions with objects, it is probably stronger than the effect in collisions of cars with big trucks (1.40 percent). The tall, rigid structure of the largest light trucks apparently deters underride and other catastrophic interactions with big trucks. Also, the mass of the largest light trucks is not much less than that of trucks and buses just over 10,000 pounds GVW. As in PC4, NITE was nonsignificant and RURAL had a positive coefficient.

TABLE 6-5

LIGHT TRUCKS: REGRESSIONS OF FATALITY RISK PER MILLION VEHICLE YEARS, BY "CASE" VEHICLE SIZE

MEASURE OF RISK: fatalities in the crash per million vehicle years
MEASURE OF SIZE: curb weight or track width of the light truck "case" vehicle
CONTROLLING FOR: driver age & sex, light truck type & equipment, road & accident conditions, etc.

Run No.: Crash Type (Codes)	**Measure of Size (Case Truck)**	**N of Fatals**	**Min Cell Size**	**N of Cells**	**Effect per 100 Pound or 1 Inch REDUCTION (%)**	**One Std Dev**	**t value**
LT1: principal rollover (11)	WEIGHT	5,030	130,700	367	**+ .81 per 100**	.73	1.11
LT1a: principal rollover (11)	TRACK WIDTH	5,030	130,700	367	**+ 2.46 per inch**	.88	2.81
LT2: hit object (12-17, 81)	WEIGHT	8,526	77,100	597	**+ 1.44 per 100**	.43	3.33
LT3: ped-bike-motorcycle (21-22)	WEIGHT	5,281	124,500	441	**- 2.03 per 100**	.40	5.13
LT4: hit big truck (31-39)	WEIGHT	2,535	259,300	256	**+ 2.63 per 100**	.63	4.18
LT5: hit passenger car (41-59)	WEIGHT	12,890	51,000	764	**- 1.39 per 100**	.29	4.72
LT6: hit another lt. truck (61-79)	WEIGHT	4,864	135,100	395	**- .27 per 100**	.42	.65

Figures 5-11 and 5-11a indicate that the smaller the light truck, the less the danger to occupants of passenger cars, and the less the overall fatality rate in collisions between light trucks and cars. LT5 estimates that each 100 pound weight reduction for light trucks reduces the overall fatality risk in collisions of light trucks with cars by 1.39 percent, statistically significant at the .01 level (t = 4.72). In the Step 1 regression, car-heavy State group 2 had a positive, rather than the usual negative coefficient. The Step 2 regression attributed a 10 percent increase in fatalities to trucks with four-wheel-drive. Since AWD trucks are used more in low-density areas, a decrease in multivehicle collisions might have been expected. The increase might be indicating that the high sills of those vehicles are especially aggressive to passenger cars. NITE and RURAL were nonsignificant, as would be expected for a crash mode associated with higher traffic density. SUV and VAN had coefficients of -.20, perhaps indicating that pickup trucks are less maneuverable in traffic, or have a more aggressive structure.

Figure 5-12 showed little or no weight-safety trend in collisions between two light trucks. In LT6, the weight-safety effect is not statistically significant (t = .65). The observed effect is a 0.27 percent reduction in fatalities per 100 pound reduction in the weight of the **case** light truck. This is nearly identical to the effect seen in car-to-car collisions (PC5). If fatality risk decreases by 0.27 percent when the case light truck is reduced by 100 pounds and the other truck is unchanged, it would decrease by double this amount, 0.54 percent, when **both** light trucks are reduced by 100 pounds. As in LT5, SUVs and vans had significantly lower fatality rates than pickup trucks.

The regression analyses strongly confirm a trend already seen in the unadjusted data: reducing a vehicle's weight increases net risk in collisions with substantially larger entities, **reduces** net risk in collisions with much smaller entities, and has little effect on net risk in collisions with entities of about the same size.

The results for light trucks in this chapter are quite close to the corresponding regression results Chapter 3, **provided** that the bias correction of 2.5 percent, as recommended in Section 4.4, is added to each of the Chapter 3 results:

	Effect on Fatalities per 100 Pound Reduction (%)			
	Chapter 5		Chapter 3 (Corrected)	
	Run No.	Effect	Run No.	Effect
Principal rollover	(LT1)	+ .81	(T1)	+1.70
Hit object	(LT2)	+1.44	(T4)	+1.20
Ped-bike-motorcycle	(LT3)	-2.03	(T5)	-1.90
Hit big truck	(LT4)	+2.63	(T6)	+2.99
Hit passenger car	(LT5)	-1.39	(T7)	- .90
Hit light truck	(LT6)	- .27	(T8)	- .80

6.3 Effect of weight reductions on the number of fatalities

The percentage changes in the fatality rate, as documented in Tables 6-2 and 6-5, are applied to the absolute numbers of fatalities in the "baseline" year 1993, to obtain estimates of the effects of 100-pound reductions of vehicle weight on the absolute numbers of fatalities. These estimates are based on the analysis method of this report: cross-sectional analyses of the existing fleets of cars and light trucks. They indicate what might happen to fatalities, in response to 100-pound weight reductions, if **historical** relationships are maintained between weight and other size parameters, such as track width, wheelbase, center-of-gravity height, and structural strength. The trends shown here are not necessarily what would happen if a specific vehicle were reduced only in weight but "everything else stays the same" or if there were radical changes in the materials or design of vehicles, or major improvements in safety technology. Specifically, the effect of weight reductions on fatalities in passenger car rollovers might be smaller if weight could be reduced without changing track width.

The 1993 FARS file used in preparing this report contained records of 40,115 fatally injured people. Table 6-6 allocates these fatalities among the principal crash types analyzed in this report, plus an "all other" category. The definitions of the single-vehicle nonpedestrian crash types, such as "principal rollover," or "fixed-object" are identical to those in Table 2-1. The definitions of the other crash types were modified, however, to minimize the number of crashes in the "all other" category. For example, collisions involving three passenger cars were not studied in any of the regression analyses: there were not enough cases for a separate regression, and they could not have been analyzed by the same method that was used for two-car crashes (defining the "case" and the "other" car). Nevertheless, it is not unreasonable to assume that the weight-safety effect will be about the same in three-car as in two-car crashes - or, at least it is more accurate to make that assumption than to toss those cases into the "all other" category and simply ignore them. The definitions of the vehicle types in Table 6-6 are based on the BODYTYP variable in FARS, as follows:

1-9, 12	Passenger cars
10-11, 14-49	Light trucks (pickups, SUVs, vans, pickup-cars)
50-79, 93	Big trucks and buses
80-90	Motorcycles and all-terrain-vehicles
other codes	"Unknown"

Table 6-6 shows that only 3,714 of the 40,115 fatalities were in the "all other" category: 2,285 of necessity, because they involved only big trucks and/or motorcycles, but no car or light truck; 911 because they involved at least one vehicle of unknown type (almost half of these are "hit-and-run" impacts with pedestrians); and the rest are complex crashes involving at least three different types of road users. The remaining 36,401 fatalities may be classified among the six fundamental crash types analyzed in the preceding section (note that the fatalities in collisions of cars with light trucks appear twice):

TABLE 6-6: 1993 FATALITY DISTRIBUTION BY TYPE OF CRASH

PASSENGER CARS		LIGHT TRUCKS	
PRINCIPAL ROLLOVERS	**1754**	**PRINCIPAL ROLLOVERS**	**1860**
hit fixed object	6364	hit fixed object	2664
hit train or animal	348	hit train or animal	161
hit parked vehicle	234	hit parked vehicle	101
other single-veh non-ped	510	other single-veh non-ped	337
HIT OBJECT	**7456**	**HIT OBJECT**	**3263**
1 car + ped/bike/nonmotorist	3334	1 lt trk + ped/bike/nonmotorist	1704
1 car + 1 motorcycle	689	1 lt trk + 1 motorcycle	469
2+ cars + ped/bike/nonmotorist	132	2+ lt trks + ped/bike/nonmotorist	26
3+ veh: car(s) + motorcycle(s)	51	3+ veh: lt trk(s) + motorcycle(s)	18
HIT PED/BIKE/MOTORCYCLE	**4206**	**HIT PED/BIKE/MOTORCYCLE**	**2217**
1 car + 1 big truck	2298	1 light truck + 1 big truck	988
3+ veh: car(s) + big truck(s)	350	3+ veh: light trucks + big trucks	123
HIT BIG TRUCK	**2648**	**HIT BIG TRUCK**	**1111**
2 veh: car to car	4504	2 veh: light truck to light truck	1050
3+ veh: all cars	521	3+ veh: all light trucks	60
HIT ANOTHER CAR	**5025**	**HIT ANOTHER LIGHT TRUCK**	**1110**

2 vehicle: 1 car + 1 light truck	4706
3+ vehicle: car(s) + light truck(s)	1045
COLLISION OF CAR WITH LIGHT TRUCK	**5751**

1 vehicle: big truck or motorcycle	2015
1 veh: unknown type	617
2 veh: big trucks and/or motorcycles only	248
2 veh: at least one unknown type	294
2 veh, different types + pedestrian(s)	149
3+ veh: big trucks and/or motorcyles only	22
3+ veh: 3 or more different vehicle types	369
ALL OTHER CRASH TYPES	**3714**

	1993 Baseline Fatalities	
	Cars	Light Trucks
Principal rollover	1,754	1,860
Hit object	7,456	3,263
Hit ped-bike-motorcycle	4,206	2,217
Hit big truck	2,648	1,111
Hit passenger car	5,025	5,751
Hit light truck	5,751	1,110
	26,840	**15,312**

Table 6-7 estimates the effect on fatalities if the weights of all **passenger cars** were to be reduced by 100 pounds. The 1754 baseline fatalities in principal rollover crashes are estimated to increase by 4.58 percent, resulting in an additional 80 fatalities. Since one standard deviation of the estimated percentage change was ±0.71 (see Table 6-2), one standard deviation of the absolute change is 0.0071 x 1754 = ±12.5 fatalities. In collisions with objects, fatalities would only increase by 1.12 percent, but since deaths in these collisions are far more numerous than in principal rollovers (7456 vs. 1754), the absolute increase, 84 fatalities, is almost the same. Here, one standard deviation is ±22.4. These increases are slightly offset by a reduction of 19 fatalities among pedestrians, bicyclists and motorcyclists hit by cars. Deaths in crashes of cars with big trucks would increase by 37. In Table 6-2, the relative effect on fatalities in car-to-car collisions was -0.31 percent if the case car was reduced by 100 pounds, and its standard deviation was ±0.24. Thus, if both cars are reduced by 100 pounds, fatalities would decrease by 0.62 percent, and the standard deviation would be ±0.48. Since there are 5025 fatalities in car-to-car collisions, there would be a reduction of 31 fatalities if all cars were to be reduced by 100 pounds, and the standard deviation would be ±24.1. The largest absolute effect is predicted in collisions between cars and light trucks: fatalities would increase by 151 if cars were reduced by 100 pounds. Those collisions are numerous (5751 baseline fatalities), and the weight-safety effect is substantial. The estimate is statistically quite precise, with a standard deviation of just 19.7.

All in all, it is estimated that the 26,840 baseline fatalities in crashes involving passenger cars would increase by 302, or 1.13 percent per 100-pound weight reduction, in the absence of any compensatory safety improvements. That point estimate is obtained by adding up the six "net fatality changes" in Table 6-7. For an interval estimate, it is first necessary to compute one standard deviation of the point estimate. Since the overall effect (point estimate) is the sum of six essentially independent statistics, its standard deviation is 43.7, the square root of the sum of the squares of the six standard deviations. Thus, the 2-sigma confidence bounds for the effect of a 100-pound weight reduction are 302 ± 2 x 43.7: an increase of 214 to 390 fatalities. Two-sigma or, in many cases, 1.645σ confidence bounds have usually been considered wide enough to include the likely range of possible error in past NHTSA evaluations. In this evaluation, iterative regression procedures and the use of exogenous coefficients could have introduced and propagated sampling or nonsampling errors; it might also be appropriate to consider wider,

TABLE 6-7

PASSENGER CARS: EFFECT OF 100 POUND WEIGHT REDUCTION
(LIGHT TRUCK WEIGHTS UNCHANGED)

Crash Type	Fatalities in 1993 Crashes	Effect of 100 Pound Weight Red.	Net Fatality Change	One Standard Deviation
Principal rollover	1754	+ 4.58 %	+ 80	12.5
Hit object	7456	+ 1.12 %	+ 84	22.4
Hit ped/bike/motorcycle	4206	- .46 %	- 19	11.1
Hit big truck	2648	+ 1.40 %	+ 37	12.6
Hit another car	5025	- .62 % (nonsignificant)	- 31	24.1
Hit light truck	5751	+ 2.63 %	+ 151	19.7
OVERALL	**26840**	**+ 1.13 %**	**+ 302**	**43.7***
±2-sigma confidence bounds			+214 to +390	
±3-sigma confidence bounds			+170 to +434	

*Standard deviation for "overall" is the root of the sum of the squares of the 6 individual standard deviations

3-sigma confidence bounds. They range from 170 to 434.

[Confidence bounds, as well as standard deviations for the relative and absolute effects in each crash type, were not presented in the October 1995 draft of this report, although the draft's discussion of statistical significance and t-values indicated the extent of sampling error. The Transportation Research Board panel recommended that confidence bounds be explicitly included in the report. As discussed above, these bounds have been computed directly from the draft's regression results. Two minor changes from the 1995 draft have had a slight effect on the overall point estimate (i.e., 302 now, vs. 322 in the draft): the nonsignificant point estimate for car-to-car crashes is shown "as is" since its sampling error has to be taken into account in computing confidence bounds, whereas it was set to zero in the draft; the point estimates in the other crash types have now been computed using a percentage effect rounded to two places beyond the decimal point, rather than one.]

Can the estimate of the weight-safety effect for passenger cars be called "precise"? Not if your idea of a "precise" estimate is an interval such as 298-306. On the other hand, in past NHTSA evaluations of vehicle regulations, the 1.645σ confidence bounds for the principal effectiveness estimate most typically ranged from ⅔ to 1⅓ times the point estimate. In some cases they were as wide as ½ to 1½ times the point estimate, and rarely were they narrower than ¾ to 1¼ times the point estimate. Those bounds were considered an acceptable level of precision, given: (1) the limited accident data available for the evaluations, (2) the fact that most safety devices are effective only in a narrowly defined group of crashes and/or have relatively small overall net effects, and (3) this is enough precision to decide whether or not a regulation has been "effective" - we don't need to know the exact effectiveness level. As can be seen from Table 6-7, the 2σ confidence bounds (214-390) for the car-weight effect are slightly narrower than ⅔ to 1⅓ times the point estimate. Even the 3σ confidence bounds (170-434) are narrower than ½ to 1½ times the point estimate. This level of precision is more than sufficient to support a conclusion that reductions in car weight, given historical patterns of car design, would be associated with increases in crash fatalities.

The effects in Table 6-7 can be compared to the results of two earlier DOT studies. NHTSA's 1991 study of car size and fatality risk estimated the overall effect of a 1000-pound weight reduction in passenger cars [7], while Mengert and Borener's 1989 analysis gave estimates for a 600-pound reduction [25]. If the percentage effects are computed per 100-pound reduction, and applied to the 1993 baseline fatalities, their results are as follows:

Effect on Fatalities of 100 Pound Reduction, Passenger Cars

	This Report	NHTSA 1991	Mengert-Borener
Rollover or object	+1.7%	+1.9%	+2.0%
Hit ped/bike/motorcycle	- .5%	not analyzed	- 2.4%
Hit another car	- .6%	negligible	- .8%
Hit light truck/big truck	+2.2%	not analyzed	+1.0%
Absolute net effect	+302	+192	+146

The six fundamental crash types have been reduced to four categories that are compatible with each of the studies. This report agrees closely with NHTSA's 1991 study on the weight-safety effect in single-vehicle nonpedestrian crashes (rollovers and collisions with objects: 1.7 vs. 1.9 percent increase) and in car-to-car collisions (negligible weight-safety effect). The only reason that the overall effect is substantially higher in this study (302 vs. 192) is that NHTSA's 1991 analysis simply did not address fatalities in collisions of cars with light trucks and big trucks, which account for over half of the overall increase in this report.

This report also agrees closely with Mengert and Borener's estimate for single-vehicle nonpedestrian crashes (1.7 vs. 2.0 percent increase) and car-to-car crashes (.6 vs. .8 percent reduction). In the other two crash modes, the results are in the same direction, but Mengert and Borener's estimates are consistently more negative (or less positive). Mengert and Borener did not adjust for driver age, sex, or State in their analyses; they, themselves, had reservations about their negative result for car-to-car collisions. If the lack of adjustment is biasing their estimates for those three crash modes, it would explain why their estimate for the overall effect (146) is lower than the one in this report.

Table 6-8 estimates that the net effect of a 100-pound reduction in **light trucks**. The 1860 baseline fatalities in principal rollover crashes are estimated to increase by a nonsignificant 0.81 percent, resulting in an additional 15 fatalities. One standard deviation of that point estimate is ±13.6. Deaths in collisions with objects are estimated to increase by 47, but that is offset by a reduction of 45 in collisions with pedestrians, bicyclists and motorcyclists. Fatalities in collisions with big trucks would increase by 29. The most important effect, in absolute terms, would be a net saving of 80 lives in collisions with passenger cars: if light trucks were reduced in weight, the benefit for the car occupants would far exceed the harm to the occupants of the light trucks. In Table 6-5, the relative effect on fatalities in collisions between two light trucks was -0.27 percent if just the case truck was reduced by 100 pounds, and its standard deviation was ±0.42. These statistics are doubled, to -0.54 and ±0.84 when both trucks are reduced by 100 pounds. Since there are 1110 fatalities in collisions between two light trucks, there would be an estimated reduction of 6 fatalities if all light trucks were to be reduced by 100 pounds, and the standard deviation would be ±9.2.

A reduction of truck weights is associated with an increase in fatalities in three types of crashes,

TABLE 6-8

LIGHT TRUCKS: EFFECT OF 100 POUND WEIGHT REDUCTION
(CAR WEIGHTS UNCHANGED)

Crash Type	Fatalities in 1993 Crashes	Effect of 100 Pound Weight Red.	Net Fatality Change	One Standard Deviation
Principal rollover	1860	+ .81 % (nonsignificant)	+ 15	13.6
Hit object	3263	+ 1.44 %	+ 47	14.1
Hit ped/bike/motorcycle	2217	- 2.03 %	- 45	8.8
Hit big truck	1111	+ 2.63 %	+ 29	7.0
Hit passenger car	5751	- 1.39 %	- 80	16.9
Hit another light truck	1110	- .54 % (nonsignificant)	- 6	9.2
OVERALL	**15312**	**- .26 %**	**- 40**	**29.7***
±2-sigma confidence bounds			-100 to +20	
±3-sigma confidence bounds			-130 to +50	

*Standard deviation for "overall" is the root of the sum of the squares of the 6 individual standard deviations and a reduction in the three other crash types. The point estimate of the net effect in all types of crashes is obtained by summing the net fatality changes in the individual crash types. The reductions more or less cancel out the increases. The point estimate is that a 100 pound reduction in truck weights, given historical patterns of truck design, would be associated with a saving of 40 lives, or 0.26 percent of the 15,312 baseline fatalities in crashes involving one or more light trucks. This reduction is not statistically significant: its standard deviation is 29.7 (the square root of the sum of the squares of the six individual standard deviations). The two-sigma confidence bounds for the estimate range from a reduction of 100 fatalities to an increase of 20 fatalities. The 3σ confidence bounds range from a reduction of 130 to an increase of 50. Even though the effects in four of the individual crash types are statistically significant, the overall effect is not, because these effects cancel each other out. The appropriate conclusion is that a reduction in the weight of light trucks would have a negligible overall effect on safety, but if there is an effect at all, it is most likely a modest **reduction** of fatalities.

It has been demonstrated throughout this report that reducing a vehicle's weight increases net risk in collisions with substantially larger entities, **reduces** net risk in collisions with much smaller entities, and has little effect on net risk in collisions with vehicles of about the same size. The only entities smaller than passenger cars are pedestrians, bicyclists and motorcyclists. Therefore, when car weight is reduced, the modest benefit for pedestrians is far outweighed by the increase in four types of crashes; the net effect is an increase in fatalities. Light trucks, on the other hand, are usually heavier than passenger cars, and are only exceeded in size and strength by big trucks and fixed objects. As shown in Table 6-8, weight reduction for light trucks might generate more benefits to smaller road users than harm for the occupants of the light trucks.

At this time, essentially two fleets of vehicles are sharing the roads: a fleet of relatively light, vulnerable passenger cars, stable in numbers and in average weight; and a fleet of relatively heavy, aggressive light trucks, growing in numbers and in average weight. In 1985, there were 116 million registered passenger cars, and the average new car weighed 2867 pounds; by 1993, there were 121 million cars, and the average new car weighed 2971 pounds (see Section 2.3 and [31], p. 22). During that period, the fleet of light trucks grew from 38 million to 57 million, and the average weight of a new truck increased from 3560 to 3901 pounds [31], p. 24. Already, in 1992, fatalities in collisions between cars and light trucks exceeded fatalities in car-to-car collisions. Continued growth in the number and weight of light trucks, in the absence of compensatory safety improvements, is likely to increase the hazard in collisions between the two fleets, while a reduction in the weight of the trucks is likely to reduce harm in such collisions.

6.4 Sensitivity tests on the coefficients for driver age and gender

The Transportation Research Board (TRB) panel's review of the October 1995 draft report noted that fatality rates were highly correlated with driver age. Since heavier cars and trucks tend to have, on the average, older drivers, unadjusted fatality rates are biased by the driver age factor. The procedure used in this report was to develop driver-age and gender coefficients from the data analyses of Chapters 3 and 4 and install them (as exogenous coefficients) into the regressions of Chapter 5-6. The TRB panel was concerned that moderate errors in these coefficients, or in the way that the model is formulated, could greatly distort the size-safety effects predicted by the models.

It was noted in Section 5.6 that the driver-age factor is not so critical in many crash types because the overinvolvement of young drivers is nearly offset by a comparable overinvolvement of older drivers in crashes of those types. It was asserted that small cars (which have many young drivers) and large cars (which have many older drivers) are on a "level playing field" in those crash types. The argument in Section 5.6 was based on direct examination of the regression coefficients for driver age.

Sensitivity tests on these coefficients allow a quantitative assessment of their impact on the ultimate estimate of the effect of reducing vehicle weight. Since the driver age and gender coefficients are exogenous and they are installed into the final regressions of the weight-safety effect, we could change these coefficients to any other values we desire, re-run the final regressions, and see what happens to the model's estimate of the weight-safety effect.

Table 6-9 presents the sensitivity tests for the analyses of passenger cars. The left two columns show the estimated relative and absolute change in fatalities per 100-pound reduction in car weight, given the baseline coefficients for driver age and gender. They recapitulate the statistics in Table 6-7. For example, a 100-pound weight reduction would be associated with a 4.58 percent increase in rollover fatalities, amounting to 80 additional deaths. In all types of crashes, fatalities would be predicted to increase by 302.

The next two columns describe the first sensitivity test: all age-gender coefficients are set to zero - i.e., age and gender are assumed to have no relation to fatality risk. That is, of course, an absurd assumption and an extreme sensitivity test in one direction. But the net impact on the estimated relationship between vehicle weight and safety is not that large. Without the age and gender effects, the model "estimates" that fatal rollovers would increase by 6.01 percent, instead of the baseline 4.58 percent, for every 100-pound reduction in car weight. Fatalities in rollovers would increase by 105, rather than the baseline 80. However, rollovers are the only type of crash where removing the age and gender effects has such a strong impact on the **relative** weight-safety effect (i.e., up from 4.58 to 6.01, an increase of 1.43). In fixed-object crashes, the impact on the percentage change is substantially smaller: up from 1.12 to 1.49, an increase of 0.37. However, since there are a lot more fatalities in fixed-object collisions than in principal rollovers, the impact on the absolute increase is nearly the same: up from 84 to 111. Removing the age and gender variables has a similar effect on the percentage change in pedestrian and car-to-car collisions. But in collisions with big trucks, and with light trucks, the net effect of controlling for the car driver's age and sex is practically nil: the fatality increase is essentially the same with baseline or zero age and gender coefficients. In those types of collisions, older drivers are as overinvolved as young drivers, and the effects fully cancel one another out.

In all types of crashes combined, a model that does not control at all for driver age and gender predicts an increase of 410 fatalities for every 100 pound weight reduction - as compared to the baseline model's 302. Even this extreme sensitivity test produces results within the 3 sigma confidence bounds of the baseline model (170-434). Similarly, the third set of columns in Table 6-9 show that a model with age and gender coefficients set at half of baseline levels would

TABLE 6-9

PASSENGER CARS: SENSITIVITY TESTS ON THE COEFFICIENTS FOR DRIVER AGE AND GENDER

(Estimated relative and absolute change in fatalities attributed to a 100 pound vehicle weight reduction)

	Baseline Age/Gender Coefficients		**Zero** Age/Gender Coefficients		**50%** of Baseline Coefficients		**150%** of Baseline Coefficients		**Double** Baseline Coefficients	
Crash Type	%	N	%	N	%	N	%	N	%	N
Principal rollover	+4.58	+80	+6.01	+105	+5.29	+93	+3.86	+68	+3.14	+55
Hit fixed object	+1.12	+84	+1.49	+111	+1.30	+97	+0.93	+69	+0.74	+55
Hit ped/bike/motorcycle	- 0.46	- 19	+0.14*	+6	- 0.16*	- 7	- 0.77	- 32	- 1.07	- 45
Hit big truck	+1.40	+37	+1.37	+36	+1.39	+37	+1.41	+37	+1.42	+38
Hit another car	- 0.62*	- 31	- 0.04*	- 2	- 0.32*	- 16	- 0.91	- 46	- 1.20	- 60
Hit light truck	+2.63	+151	+2.67	+154	+2.65	+152	+2.61	+150	+2.60	+150
TOTAL		**+302**		**+410**		**+356**		**+246**		**+193**

*Not a statistically significant effect

estimate an increase of 356 fatalities per 100 pound car-weight reduction.

Conversely, when we install age and gender effects stronger than the baseline coefficients, the models attribute to a 100-pound weight reduction: a smaller-than-baseline fatality increase in rollovers and collisions with objects, a larger decrease in pedestrian and car-to-car crashes, and essentially the baseline effect in collisions with big trucks and light trucks. At 150 percent of baseline coefficients for driver age and gender, the model says that fatalities would increase by 246, per 100-pound weight reduction, and at double baseline coefficients, the model says fatalities would increase by 193. Again, even the last prediction is within the 3σ confidence bounds of the baseline model.

The plausible range of true values for the age and gender coefficients is undoubtedly narrower than the span covered in these sensitivity tests. The actual relationship between driver age and fatal-accident risk is not really unknown. The U-shaped trends are readily seen in aggregate data on overall fatality rates, per capita or per 100,000 licensed drivers, such as those displayed in NHTSA's *Traffic Safety Facts 1995* [Report No. DOT HS 808 471, pp. 88 and 94]:

Age	Fatalities Per 100,000 Population		Fatal Involvements Per 100,000 Drivers
16-20	31.9		65.2
21-24	29.8		47.1
25-34	19.4		33.0
35-44	15.1		27.1
45-54	13.4		23.5
55-64	13.9		21.2
65-74	16.6	65-69	19.1
75+	26.2	70+	27.9

Aggregate risk is about 2-3 times as large for teenage drivers, and 1½-2 times as large for old drivers, as for people in the lowest-risk age groups. Rates typically **decrease** by 4-6 percent for each year that a driver gets older, from age 16 to about 35. For example, a decrease from 31.9 at age 18 to 15.1 at age 35 (fatalities per 100,000 population) is a 4.5 percent reduction per year; a decrease from 65.2 at age 18 to 27.1 at age 35 (fatal involvements per 100,000 drivers) is a 5.3 percent reduction per year. At age 35 or slightly higher, the rates level off. Finally, they **increase** by 3-4 percent for each year that a driver gets older from about age 55 onwards (e.g., an increase from 13.9 at age 55 to 26.2 at age 75 amounts to a 3.2 percent annual increase). Give or take a percent or two, that's almost the same as the exogenous driver age coefficients in all the baseline models, except rollovers (where the young-driver effect is stronger and the old-driver effect is negligible). Clearly, the true age coefficients are not zero, and it is equally unlikely that they would be as high as double the baseline exogenous coefficients (e.g. 10-15 percent in many crash types), since that simply wouldn't be consistent with actual fatality rates.

In summary, more than half of the observed weight-safety effect for passenger cars comes from collisions with light trucks or big trucks (188 out of the 302 baseline increase per 100-pound car-weight reduction). In both of those crash types, large variations in the driver-age and gender coefficients have little effect on the model's predicted weight-safety relationship. Even when all types of crashes are taken into account, the overall weight-safety effect varies within the sampling-error range of the baseline estimate.

Table 6-10 presents the corresponding sensitivity analyses for light trucks. The sensitivity of the weight-safety effect is somewhat larger, relatively speaking, than in passenger cars. Except in collisions between light trucks and big trucks, the stronger the driver-age and gender coefficients, the more favorable the predicted effect of a 100-pound weight reduction. The baseline prediction was that a 100-pound weight reduction would be associated with a decrease of 40 fatalities. That changes to an **increase** of 86 fatalities if the age and gender coefficients are cut back to zero, and an increase of 23 fatalities if those coefficients are cut back to 50 percent of baseline levels. On the other hand, if the coefficients are augmented to 150 percent of baseline levels, the model predicts a decrease of 103 fatalities, and at double baseline levels, the model predicts a decrease of 164 fatalities. The results from the 50 and 150 percent sensitivity tests are very close to the 2-sigma confidence bounds for the baseline model (-100 to +20). The results from the zero and 200 percent sensitivity tests comprise a slightly wider range than the 3σ confidence bounds for the baseline model (-130 to +50).

6.5 Sensitivity tests: exclusion of high-performance and sporty vehicles

The TRB panel expressed a widely-held view that small cars have more aggressive drivers than large cars, even after controlling for driver age, etc. They asserted that, to a greater or lesser extent, it's not the small cars, but rather their drivers that are responsible for the higher fatality rates: "Insofar as more aggressive drivers tend to drive smaller cars, for example, the effect of aggressiveness is incorrectly incorporated into the estimated effect of weight - such that reductions in weight appear to have a greater impact on fatalities than is in fact true" [p. 5 of the TRB report].

This view was probably true in the 1950's, when many light cars were European sports cars and most heavy cars were domestic sedans. Today, the typical small car may be a sedan and its driver might be a young, married woman on her way to work or shopping. Today's cars that have a wide reputation for high performance and a clientele of young male drivers typically weigh close to 3,000 pounds: a little more than the average car on the road.

The TRB panel recommended a specific procedure to identify whether the inclusion of make-models with aggressive drivers biases the calibration of the weight-safety relationship: "Another sensitivity test could attempt to separate, at least partially, the effects of driver aggressiveness from vehicle weight on fatality risk by removing from the data base cars known to be associated with risk taking behavior and high fatality rates, such as certain sports cars and sport utility vehicles, and then running the regression" [p. B-12 of the TRB report].

Table 6-11 shows the results of excluding sporty and high-performance make-models from the

TABLE 6-10

LIGHT TRUCKS: SENSITIVITY TESTS ON THE COEFFICIENTS FOR DRIVER AGE AND GENDER

(Estimated relative and absolute change in fatalities attributed to a 100 pound vehicle weight reduction)

	Baseline Age/Gender Coefficients		**Zero** Age/Gender Coefficients		**50%** of Baseline Coefficients		**150%** of Baseline Coefficients		**Double** Baseline Coefficients	
Crash Type	%	N	%	N	%	N	%	N	%	N
Principal rollover	+0.81*	+15	+2.09	+39	+1.44	+27	+0.16*	+3	- 0.47*	- 9
Hit fixed object	+1.44	+47	+2.28	+74	+1.86	+61	+1.02	+33	+0.61*	+20
Hit ped/bike/motorcycle	- 2.03	- 45	- 1.39	- 31	- 1.71	- 38	- 2.35	- 52	- 2.67	- 59
Hit big truck	+2.63	+29	+2.84	+32	+2.73	+30	+2.53	+28	+2.43	+27
Hit passenger car	- 1.39	- 80	- 0.65	- 37	- 1.02	- 59	- 1.76	- 101	- 2.13	- 122
Hit another light truck	- 0.54*	- 6	+0.83*	+9	+0.14*	+2	- 1.23*	- 14	- 1.92	- 21
TOTAL		**- 40**		**+86**		**+23**		**- 103**		**- 164**

*<u>Not</u> a statistically significant effect

TABLE 6-11

PASSENGER CARS: SENSITIVITY TESTS ON THE INCLUSION/EXCLUSION OF HIGH-PERFORMANCE VEHICLES

(Estimated relative and absolute change in fatalities attributed to a 100 pound vehicle weight reduction)

	Baseline: Includes All Cars		Excluding Very High-Performance Cars		Excluding Very + Somewhat High-Perf. Cars		Limited to 4-Door Sedans	
Crash Type	%	N	%	N	%	N	%	N
Principal rollover	+4.58	+80	+5.00	+87	+5.26	+92	+5.18	+91
Hit fixed object	+1.12	+84	+1.66	+124	+1.83	+136	+2.20	+164
Hit ped/bike/motorcycle	- 0.46	- 19	- 0.59	- 25	- 0.59	- 25	- 0.41*	- 17
Hit big truck	+1.40	+37	+1.36	+36	+1.38	+37	+1.12	+30
Hit another car	- 0.62*	- 31	- 0.27*	- 14	- 0.25*	- 13	- 0.07*	- 4
Hit light truck	+2.63	+151	+2.81	+162	+3.01	+173	+2.45	+141
TOTAL		**+302**		**+370**		**+400**		**+405**

*Not a statistically significant effect

weight-safety analyses for passenger cars. The left two columns recapitulate the baseline model, predicting an increase of 302 fatalities per 100-pound weight reduction. The next two columns show what happens when the Step 2 regressions, PC1-PC6 (see Section 6.1) are rerun, excluding those cars that are widely reputed for being sporty, high-performance, high-horsepower, and/or attracting an especially young, carefree clientele:

All convertibles	Dodge Charger	Dodge Daytona	Dodge Stealth
Dodge Viper	Plymouth Turismo	Ford Mustang	Mercury Capri
Chevrolet Camaro	Chevrolet Corvette	Pontiac Fiero	Pontiac Firebird
BMW 600	Nissan 300ZX	Honda CRX/del Sol	Acura NSX
Jaguar XJ-S	Mazda Miata	Mazda RX-7	Mercedes SL
All Porsche	Subaru SVX	Toyota Supra	Mitsubishi 3000GT

After these cars are excluded, and the regression is run on the remaining cars, the predicted effect of a 100-pound weight reduction **increases** from 302 to 370 fatalities. In other words, the result of the sensitivity test runs counter to the view that excluding the aggressively-driven cars would dampen the observed weight-safety effect. The reason for this will be evident from the weights of the excluded cars. In the preceding list, only the Dodge Charger, Plymouth Turismo, Honda CRX/del Sol and Mazda Miata are substantially lighter than the average car on the road (2900 pounds). Most of the high-volume cars are close to average weight (Ford Mustang, 2900 pounds) or somewhat heavier (Camaro/Firebird, 3200 pounds). Needless to say, if most of the high-performance cars had been substantially heavier than average, their inclusion would have created a bias against heavy cars. But even in the present situation, where most high-performance cars are close to average-weight, their inclusion tends to make the baseline model **understate** the weight-safety relationship. Their inclusion puts some outliers (cars with high fatality rates) in the middle of the spectrum, and it slightly obscures the general trend of declining fatality rates as car weight increases. Nevertheless, even this new estimate is within the 2-sigma confidence bounds of the baseline model (+214 to +390).

The preceding list of make-models probably includes most of those that people consider "very high-performance." However, there are quite a few other make-models, not quite as sporty as that group, but definitely racier than the typical family sedan. The next two columns of Table 6-11 show the results of regressions excluding the following make-models **as well as** the preceding ones:

Plymouth Laser	Eagle Talon	Ford Probe	Ford Thunderbird
Mercury Cougar	Buick Reatta	Buick Riviera	Cadillac Allante
Cadillac Eldorado	Chev Chevette 2 dr	Chev Monte Carlo RWD	Chev Sprint 2 dr
Geo Metro 2 dr	Geo Storm	Olds Toronado	Pont Grand Prix RWD
Pontiac T-1000 2 dr	VW Scirocco	BMW 850	Nissan 240SX
Nissan NX	Nissan Pulsar	Honda Prelude	Mazda MX-3
Mazda MX-6	Renault Fuego	Subaru XT	Toyota Celica
Toyota MR-2	Mitsubishi Eclipse	Hyundai Scoupe	Merkur X4RTi

With the remaining make-models, the calibrated effect of a 100-pound weight is an increase of 400 fatalities, higher than in the baseline model and slightly higher than in the preceding case. Again, most of the above make-models are fairly close to average-weight; the only models substantially lighter than average are the 2-door Sprint/Metro, 2-door Chevette/T-1000, Geo Storm, Subaru XT and VW Scirocco. The predicted increase of 400 is still within the 3σ bounds of the baseline model (+170 to +434).

In general, a "family" car is a 4-door sedan, hatchback or station wagon. People who choose cars that are racy, sporty or have a high-performance image will usually prefer 2-door cars, such as coupes or convertibles. The preceding lists include almost every make-model that is available purely as a 2-door. But there are other make-models available in 2-door **and** 4-door styles. It is safe to say that, even for those make-models, the purchasers of the 2-door versions are likely to be the more aggressive drivers ([16], pp. 3-7). As a final sensitivity test, **all** 2-door cars, including convertibles are removed from the data. So are station wagons. The Step 2 regressions (without the body-style variables) are run on a homogeneous data set consisting exclusively of 4-door sedans and hatchbacks. The right columns of Table 6-11 show that this test associates an increase of 405 fatalities with a 100-pound weight reduction: even a little more than in the two preceding tests, although still within the 3σ bounds of the baseline model (+170 to +434).

It is especially interesting to look at the sensitivity test results by type of crash. Most of the increase over the baseline may be found in collisions with **fixed objects**. The predicted effect of a 100-pound weight reduction is +84 in the baseline, and it increases to +124, +136 and +164 as ever more high-performance vehicles are excluded. In rollovers and car-to-car collisions, there is a modest trend toward greater increases (or smaller decreases). But in collisions with pedestrians, big trucks and light trucks, there is only a small change and/or an inconsistent pattern. It is understandable that collisions with trucks or pedestrians would be unaffected: even aggressive drivers, unless they are seriously impaired, are likely to exert self-control in the presence of trucks or in areas crowded with pedestrians. They will be somewhat aggressive around other cars, but most strongly so on the open road. The largest increases might be expected in single-vehicle loss-of-control crashes: fixed objects and rollovers. However, at least during the 1985-93 time frame, high-performance cars have typically had short wheelbases and wide track widths relative to other cars of similar mass (see Appendix D). The wide track width gives some protection against rollovers, partially compensating for the aggressiveness of the drivers. But there is no comparable protection against fixed-object crashes, and the short wheelbases could even be an aggravating factor. High-performance cars, mostly of average weight, have high fixed-object collision rates, and this partially masks the trend of decreasing fatality risk as car weight increases.

The TRB panel also expressed a widely-held view that the smallest light trucks have the most aggressive drivers. Specifically, small, light SUVs with open bodies are favored by young males for recreational driving. This may be true; however, the really small SUVs only account for a meager portion of the SUV market. In absolute terms, the largest number of aggressive young male drivers can probably be found in the much more popular mid-sized SUVs (Bronco 2, Explorer, S-Blazer), whose weights are a few hundred pounds lower than, or equal to the average for all light trucks including pickup trucks and vans.

Table 6-12 shows the results of sensitivity tests in which selected sporty make-models have been excluded from the weight-safety analyses for light trucks. The left two columns recapitulate the

TABLE 6-12

LIGHT TRUCKS: SENSITIVITY TESTS ON THE INCLUSION/EXCLUSION OF SPORTY VEHICLES

(Estimated relative and absolute change in fatalities attributed to a 100 pound vehicle weight reduction)

	Baseline: Includes All Light Trucks		Excluding Sporty SUVs		Limited to Pickup Trucks	
Crash Type	%	N	%	N	%	N
Principal rollover	+0.81*	+15	+1.33*	+25	+2.88	+54
Hit fixed object	+1.44	+47	+1.59	+52	+2.17	+71
Hit ped/bike/motorcycle	- 2.03	- 45	- 1.75	- 39	- 1.46	- 32
Hit big truck	+2.63	+29	+2.40	+27	+2.51	+28
Hit passenger car	- 1.39	- 80	- 1.73	- 99	- 1.71	- 98
Hit another light truck	- 0.54*	- 6	- 0.63*	- 7	- 0.43*	- 5
TOTAL		**- 40**		**- 41**		**+18**

*<u>Not</u> a statistically significant effect

baseline model, that predicted a decrease of 40 fatalities per 100-pound weight reduction. The next two columns show what happens when the Step 2 regressions, LT1-LT6 (see Section 6.2) are rerun, excluding all SUVs that are widely reputed for being sporty and ideal for personal, recreational travel by a young, carefree clientele:

Jeep Cherokee	Jeep CJ-7	Jeep CJ-8	Jeep Wrangler
Dodge Ramcharger	Ford Bronco	Ford Bronco 2	Ford Explorer 2 dr
Chev/GMC K-Blazer	Chev/GMC S-Blazer 2 dr	Chev/GMC Tahoe/Yukon	Geo Tracker
Nissan Pathfinder	Isuzu Amigo	Isuzu Rodeo	Isuzu Trooper 2 dr
Toyota 4-Runner	Toyota Land Cruiser	Mitsubishi Montero 2 dr	Suzuki Samurai
Suzuki Sidekick	Daihatsu Rocky		

In other words, the data are limited to pickup trucks, vans, vehicles on SUV bodies that are often used like passenger vans (e.g., Chevrolet/GMC Suburban), and other family-oriented SUVs (e.g., 4-door Ford Explorer). Table 6-12 shows that excluding the sporty SUVs did not have any real impact on the bottom-line, or in any of the individual crash types. The model predicts a decrease of 41 fatalities, as compared to the baseline prediction of 40. Since most of the sporty SUVs are somewhat below, or near the average weight for all light trucks, their inclusion in the data did not severely distort the weight-safety trend shown by other types of trucks.

As a second sensitivity test, **all** SUVs and vans are removed from the data, and the Step 2 regressions (without the truck-type variables) are run on the data set consisting exclusively of pickup trucks. This limited data set is more homogeneous in two ways: (1) all pickup trucks have fundamentally the same structure and shape; as they get heavier, they get proportionately wider, longer and taller; (2) the drivers of small and large pickup trucks have more in common with each other, up to a point, than with the drivers of SUVs or vans. The right columns of Table 6-12 show that this test associates an **increase** of 18 fatalities with a 100-pound weight reduction in pickup trucks. This result differs from the baseline and the preceding test, both of which predicted decreases; nevertheless, an increase of 18 is still within the 2σ bounds of the baseline model (-100 to +20).

Interestingly, rollovers are the only crash type where there is a qualitative difference between this test and the two preceding ones. When the data include all light trucks, or all light trucks except sporty SUVs, the association between mass and rollover fatality risk is nonsignificant; for pickup trucks alone, each 100-pound weight reduction is associated with a statistically significant 2.88 percent increase in fatality risk (which is just over half of the 4.58 percent effect seen in passenger cars). However, that result is not surprising. We have already seen a significant association between track width and rollover risk in light trucks (Table 6-5) as well as passenger cars (Table 6-2). When trucks of all shapes and types are combined, there is little correlation between mass and track width. But among pickup trucks alone, it is generally true that the greater the mass, the greater the track width. Presumably, if weight reductions could be achieved without comparable reductions in track width, there might be little weight-safety effect even in pickup-truck rollovers.

6.6 Linearity of the weight-safety relationships

The TRB panel concurred with a widely-held intuition that "the predicted effect of a reduction in vehicle weight on societal risk depends on how the weight reduction is actually distributed across the fleet. For example, a reduction in the weight of small cars is likely to be far more harmful than a reduction in the weight of larger cars or light trucks" [p. 6 of the TRB report]. At first glance, that would appear to conflict with the models formulated in this report. One model assigns the same 1.13 **percent** increase in fatality risk given a 100-pound weight reduction in cars, no matter whether the reduction is applied to heavy or light cars. Another model assigns the same 0.26 **percent** fatality reduction given a 100-pound weight reduction in light trucks, no matter whether the reduction is applied to larger or smaller light trucks. On closer inspection, the widely-held intuition and the models are not necessarily in conflict.

For example, our models imply that truck weights could be reduced, as long as car weights are held constant, with little cost and probably even a small benefit to society. Conversely, given a reduction in car weight, while truck weights are held constant, the models would predict an increase in fatalities. Thus, in our models, consistent with intuition, the effect on societal risk is quite dependent on whether the weight reduction is applied to cars or light trucks.

But what if we limit weight reductions to cars, and omit light trucks from consideration for the time being? The widely-held intuition appears to be that it is better to reduce the weight of large cars, leaving small cars unchanged, than to apply the weight reductions equally across the board. This view is also, up to a point, consistent with our model. Even if the **percent** change in fatality risk is the same for a 100-pound weight reduction in large cars or small cars, the **absolute** change will be larger in the small cars. Since large cars have lower fatality risk than small cars, a 1 percent increase among the large cars is a smaller absolute number of fatalities than a 1 percent increase among the small cars.

However, there are many who believe that the difference goes further than this. They believe that a 100-pound reduction in large cars would have a small **percentage** effect, or maybe even no societal effect at all, while a weight reduction in small cars would have a large percentage effect. In that case, our model, which assumes a linear relationship between car weight and the logarithm of the fatality rate, would seriously misfit the data.

The validity of the linear model can be demonstrated by graphing, by car weight: (1) the log of the actual fatality rate (after adjustment for all variables except car weight) and (2) the log of the predicted fatality rate. The model's predicted log-fatality rates will in all cases follow a straight line. If the linear model is valid, the actual data points should follow that line, give or take sampling error. But if the relative weight-safety relationship is stronger for small cars than large cars, we should see the actual data points diverging from the straight line: dipping sharply below the line on the left half of the graph, and then leveling out on the right half.

In addition to testing the uniformity in the weight-safety effect, this analysis will also address another concern raised by TRB: model validation. "One can postulate and fit a linear regression model to the logarithm of the odds of a fatality. Whether in fact the model should be linear in each of the predictor variables is a question that should be addressed. **Plotting residuals from a**

fit to the data is just one technique that can be used to assess the validity of the linearity assumption [emphasis added]....The possibility of serious outlier effects...[or] extreme predictor values (leverage points) should also be assessed" [p. B-5 of the TRB report].

Thus, in perusing Figures 6-1 to 6-12, we should be on the lookout for

- In general, actual data points that poorly fit the model's regression line
- Specifically, a pattern in the actual data points of initial sharp drop followed by leveling out, indicating a weight-safety effect that gets weaker as the vehicles get heavier.
- Any tendency of the regression line to be influenced by outlying actual data points and diverted from the main body of actual data points.

Figure 6-1 graphs the adjusted actual fatality rate (ADJACTL, shown as "A") and the predicted fatality rate (ADJEXP, shown as "•"), by car weight, in passenger car rollovers. The model was run for all cars **except** the very sporty and high-performance models (the first group of make-models listed in Section 6.5). The horizontal axis is car weight. ADJEXP is the logarithm of the fatality rate, normalized to the rate for a 2000-pound car, with all control variables $a_1,\ldots,a_n$ other than vehicle weight set to their average value:

$$\text{ADJEXP}(w) = \log R_{\text{predicted}}(w,\bar{a}_1,\ldots,\bar{a}_n) - \log R_{\text{predicted}}(2000,\bar{a}_1,\ldots,\bar{a}_n)$$

In the case of rollovers, where the regression excluding very performance cars predicted a 5.00 percent increase in fatality risk for every 100-pound weight reduction (see Table 6-11), ADJEXP (w) = .000500 (w - 2000). The data are subdivided into 100-pound class intervals of weight (e.g., 1850-1949, 1950-2049, etc.). Class intervals with fewer than 2,000,000 Step-1-adjusted vehicle registration years (REGS) are not shown in Figure 6-1. For a class-interval of weight with centroid w, the adjusted actual fatality rate ADJACTL (w) is ADJEXP (w) plus the average residual of actual vs. expected fatality rates for the various make-models (m) whose weight is within that class interval:

$$\text{ACTL}(w) = \Sigma_m \{\log[R_{\text{actual}}(w_m,\bar{a}_{1m},\ldots,\bar{a}_{nm})] \times \text{REGS}(m)\} / \Sigma_m \text{REGS}(m)$$
$$\text{EXPEC}(w) = \Sigma_m \{\log[R_{\text{predicted}}(w_m,\bar{a}_{1m},\ldots,\bar{a}_{nm})] \times \text{REGS}(m)\} / \Sigma_m \text{REGS}(m)$$
$$\text{RESID}(w) = \text{ACTL}(w) - \text{EXPEC}(w)$$
$$\text{ADJACTL}(w) = \text{ADJEXP}(w) + \text{RESID}(w)$$

Figure 6-1 shows a very good linear fit for adjusted rollover fatality risk by car weight. The actual data points closely follow the model's trend line, give or take moderate sampling error, throughout the spectrum of car weights. There is no evidence that the actual fatality rates have a sharper-than-trend drop at the lower weights or a leveling out at the higher weights. Nor are there any important outliers that appear to divert the trend line from the pattern in the actual data. In other words, Figure 6-1 suggests that rollover risk increases by a fairly constant 5 percent per 100-pound weight reduction, for small cars as well as large cars.

Figure 6-2 shows the actual and expected fatality rates in collisions of cars with fixed objects, after adjusting for all other control variables. The fit is not as good as in Figure 6-1. There

FIGURE 6-1

PASSENGER CAR ROLLOVERS: FATALITY RISK BY VEHICLE WEIGHT

(After adjustment for all other control variables; excluding very high-performance cars)

A = actual rate; ● = rate predicted by the model

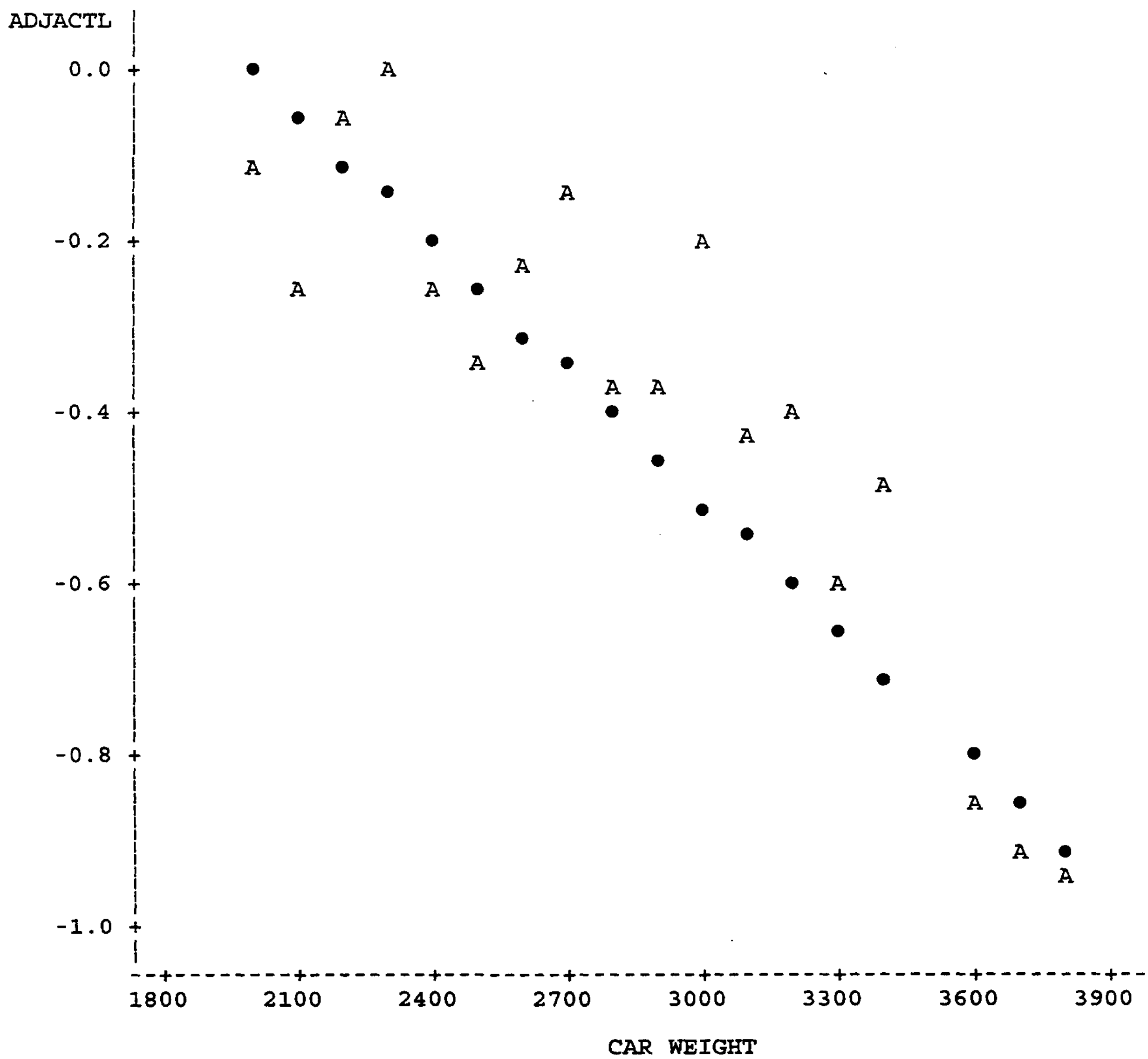
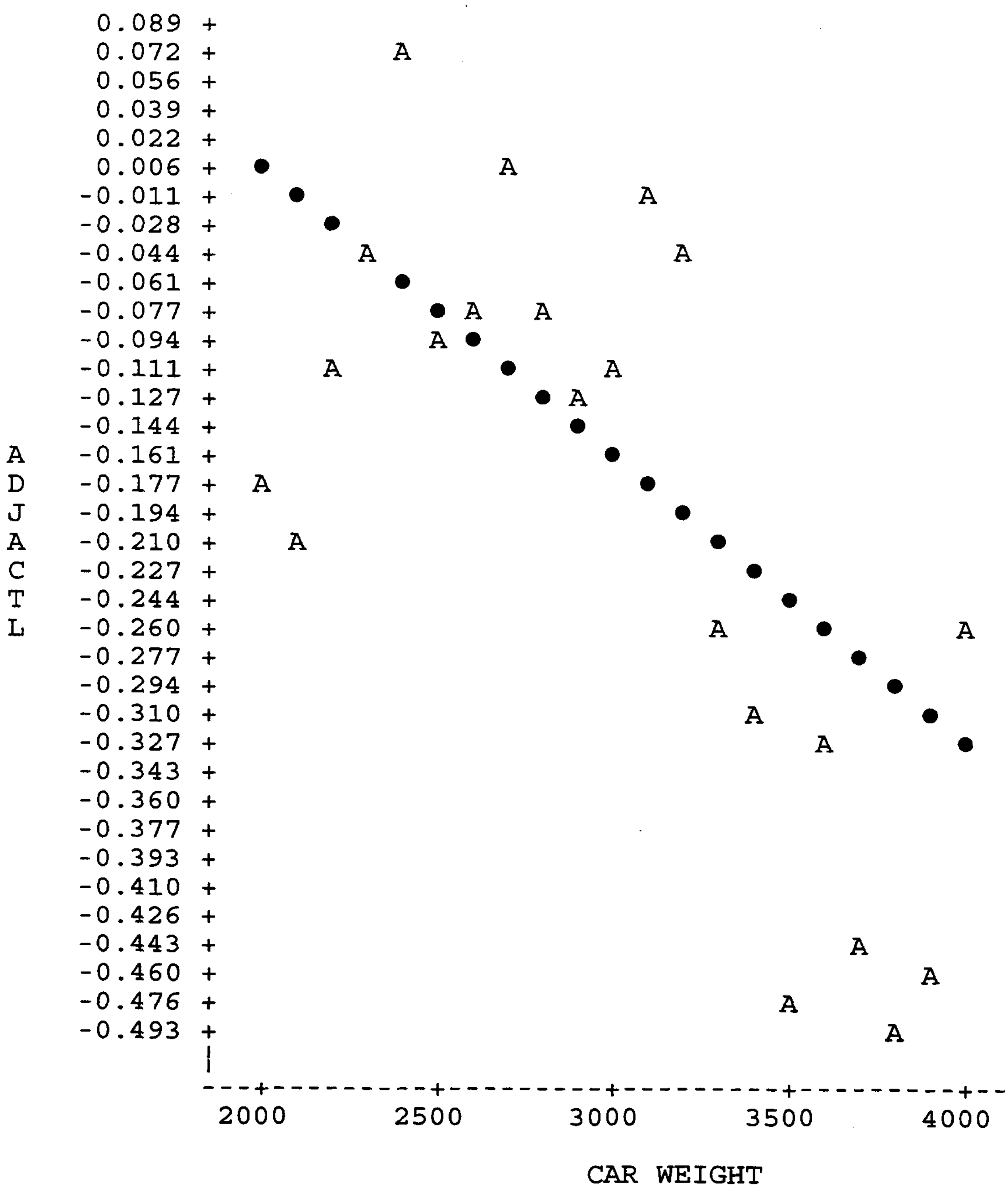


FIGURE 6-2

PASSENGER CAR COLLISIONS WITH FIXED OBJECTS
FATALITY RISK BY VEHICLE WEIGHT

(After adjustment for all other control variables; excluding very high-performance cars)

A = actual rate; ● = rate predicted by the model



appears to be more sampling error (noise relative to signal). There may also be some departure from linearity, in the sense that most of the actual points on the right side are below the trend line. But that is a departure in the opposite direction from the one we were on the lookout for. If anything, it suggests the weight-safety relationship may be getting stronger as weight increases.

Figure 6-3 addresses collisions of passenger cars with pedestrians, bicyclists or motorcyclists. The graph is an excellent example of a linear trend with a low level of statistical significance. There is a lot of noise relative to signal, but the residuals do not seem to show any pattern; the actual points are scattered above and below the trend line throughout the range of car weights.

Figure 6-4 graphs the fatality trend in collisions between cars and heavy trucks, as a function of car weight. Its appearance is quite similar to Figure 6-3, except that fatality risk decreases, rather than increases, as car weight goes up. Again, this is a linear trend with low statistical significance, and no obvious pattern in the residuals.

In Section 6.1, the baseline regression for car-to-car collisions - the risk of a fatality in **either** car as a function of the weight of the case car - did not produce a statistically significant coefficient for car weight. Did that happen because case-car weight and the likelihood of a fatality in either car are simply unrelated, or because the relationship is so nonlinear as to escape detection by a linear regression? Figure 6-5 shows the fatality rates in two-car collisions as a function of the weight of the case car. The actual fatality rates appear to be randomly scattered and do not show any pattern, linear or otherwise, relative to car weight.

Figure 6-6 addresses the crash type in which the weight-safety effect had the highest level of statistical significance. It graphs the fatality risk in collisions between cars and light trucks, as a function of car weight. The actual, adjusted fatality rates fit the linear trend line exceedingly well. In fact, this is one of the best linear fits ever found in any analysis of fatal traffic accident rates in a NHTSA evaluation.

Figures 6-7 - 6-12 present the corresponding weight-safety trends in crashes involving light trucks. Sporty SUVs have been excluded from the analyses that produced the graphs. Since the data base for light trucks is smaller than that for cars, all of these figures will tend to show more sampling error than Figures 6-1 - 6-6. Figure 6-7 shows the trends in light-truck rollovers. In the baseline model for rollovers, the regression coefficient for truck weight was negative, but fell short of statistical significance. Consistent with that result, Figure 6-7 shows actual fatality rates that are randomly scattered, but with just a hint of a downward trend as weight increases. There is no evidence of a nonlinear effect, or of a stronger weight-safety trend in the light trucks than in the heavier ones.

Figure 6-8 graphs fatality rates in collisions with fixed objects. While there is a definite tendency of decreasing risk as truck weight increases, there are some exceptions to a good linear fit. The actual fatality rates follow the trend line well at first, then appear to level off in the middle of the weight range, and drop sharply again at the top of the range. It is possible that the outliers on the left and right are making the trend line steeper than it ought to be. Nevertheless, the data do not suggest that a nonlinear model would be better than the linear one, or that the weight-safety effect is stronger for the smaller light trucks.

FIGURE 6-3: PASSENGER CAR COLLISIONS WITH PEDESTRIANS, BICYCLISTS AND MOTORCYCLISTS: FATALITY RISK BY CAR WEIGHT

(After adjustment for all other control variables; excluding very high-performance cars)

A = actual rate; ● = rate predicted by the model

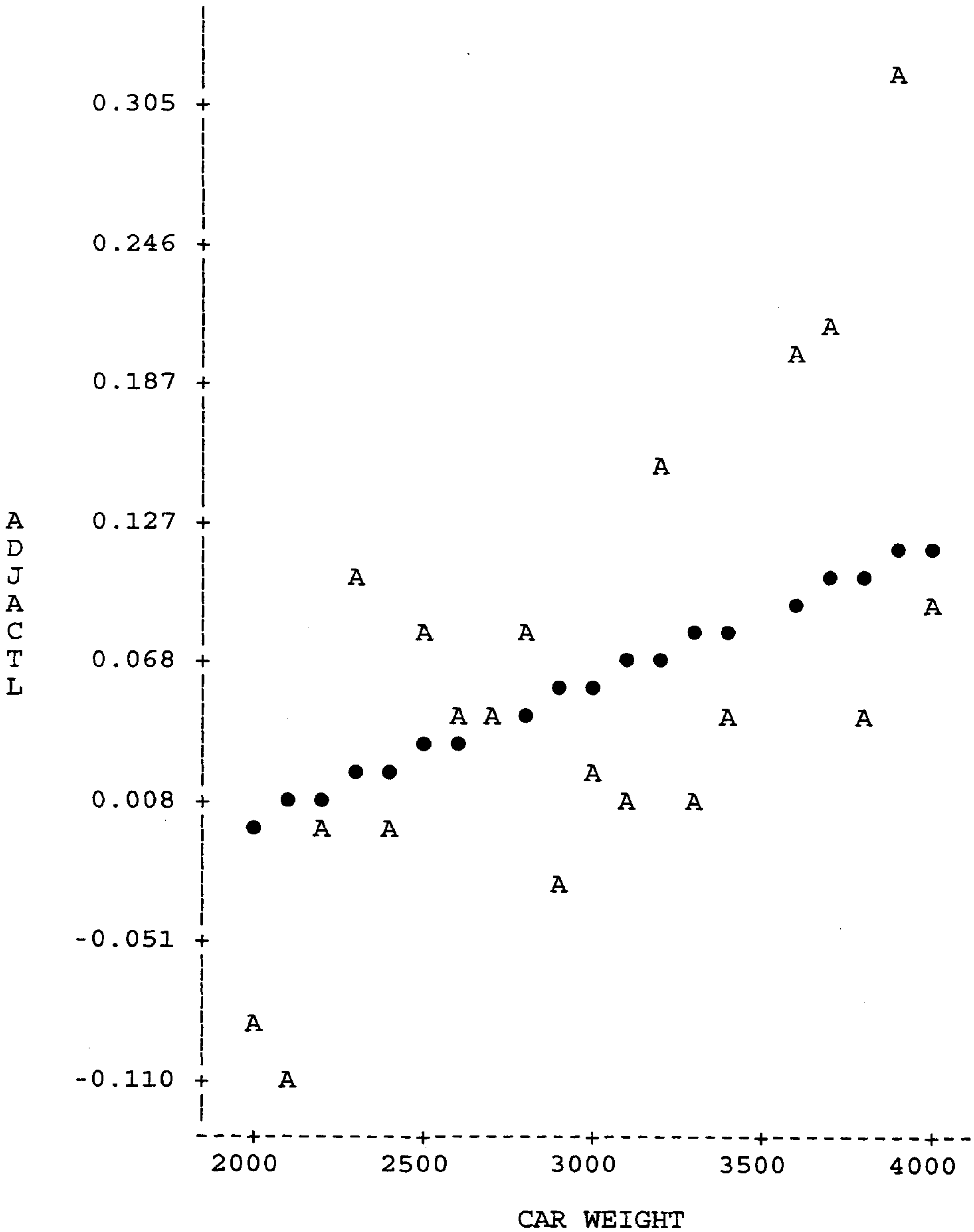


FIGURE 6-4

PASSENGER CAR COLLISIONS WITH HEAVY TRUCKS
FATALITY RISK BY CAR WEIGHT

(After adjustment for all other control variables; excluding very high-performance cars)

A = actual rate; ● = rate predicted by the model

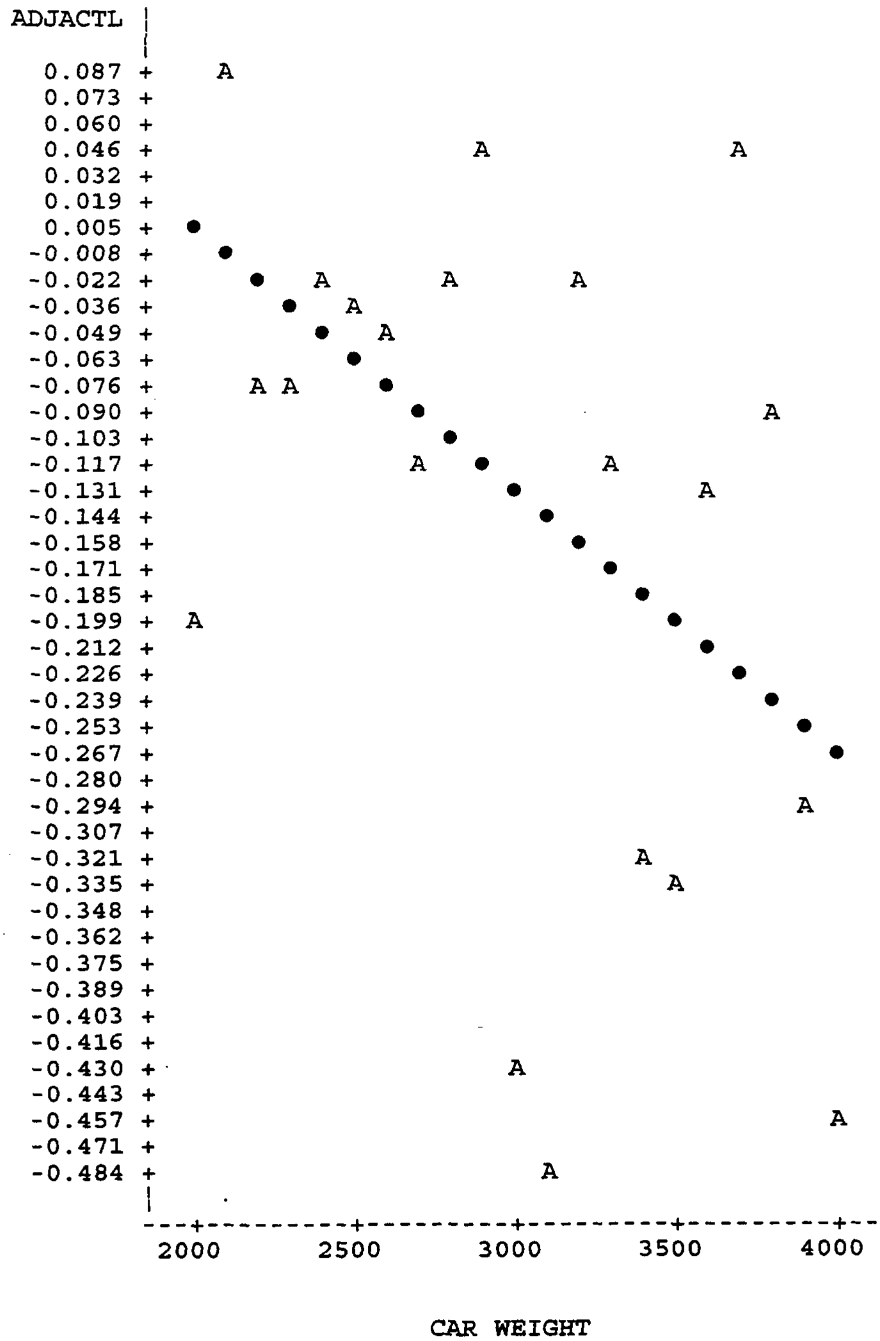


FIGURE 6-5

COLLISIONS BETWEEN TWO PASSENGER CARS
FATALITY RISK BY CASE VEHICLE WEIGHT

(After adjustment for all other control variables; excluding very high-performance cars)

A = actual rate; ● = rate predicted by the model

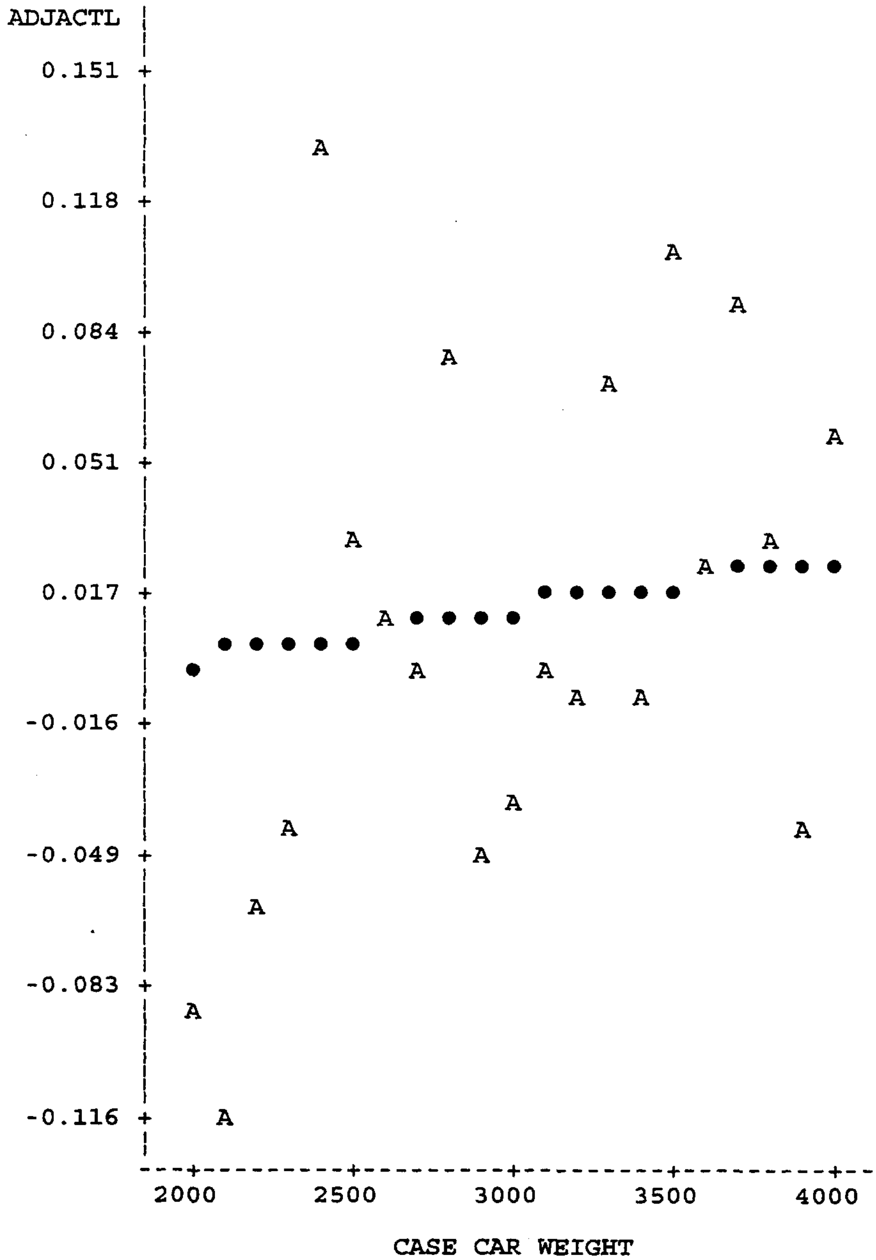


FIGURE 6-6

PASSENGER CAR COLLLISIONS WITH LIGHT TRUCKS
FATALITY RISK BY CAR WEIGHT

(After adjustment for all other control variables; excluding very high-performance cars)

A = actual rate; ● = rate predicted by the model

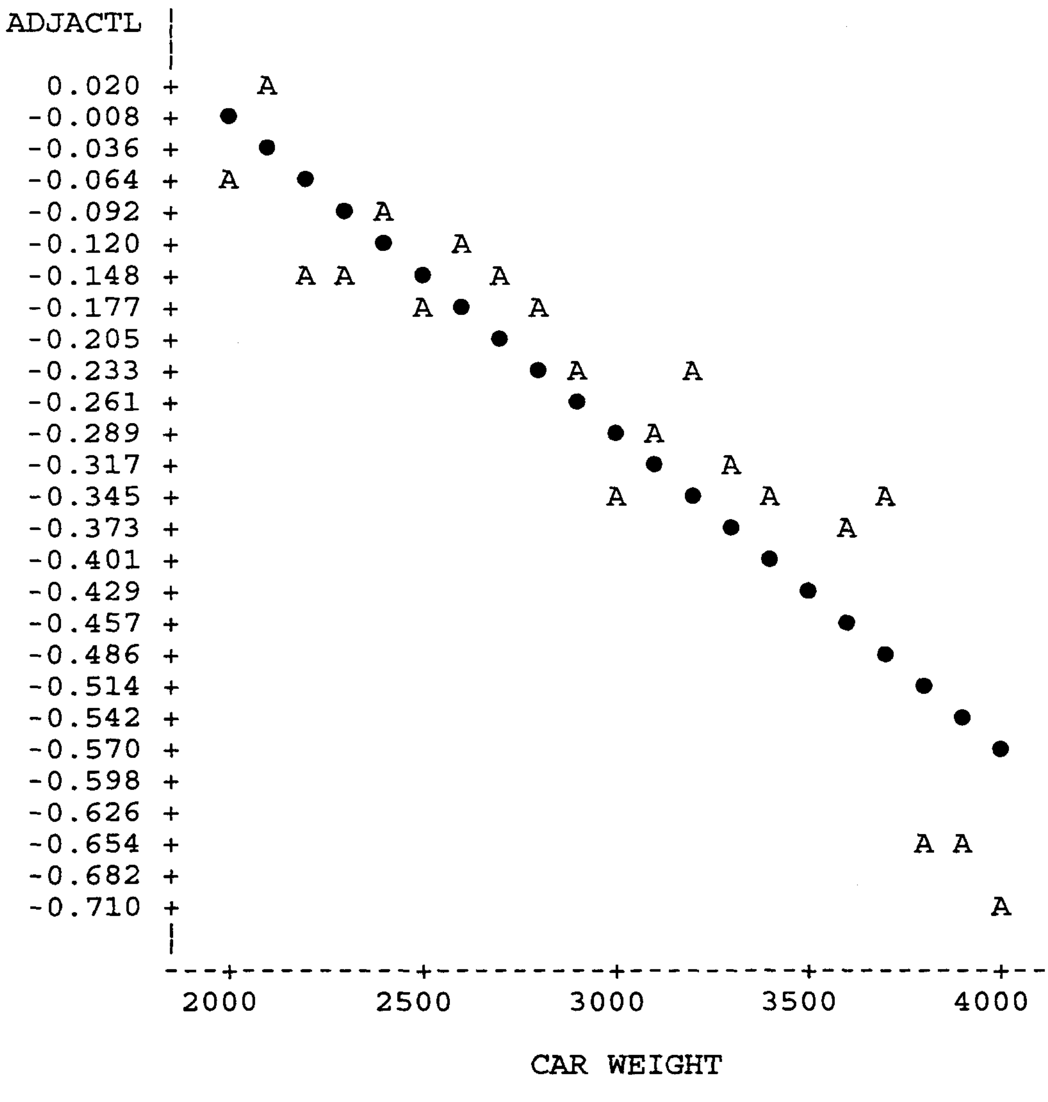


FIGURE 6-7

LIGHT TRUCK ROLLOVERS: FATALITY RISK BY VEHICLE WEIGHT

(After adjustment for all other control variables; excluding sporty SUVs)

A = actual rate; ● = rate predicted by the model

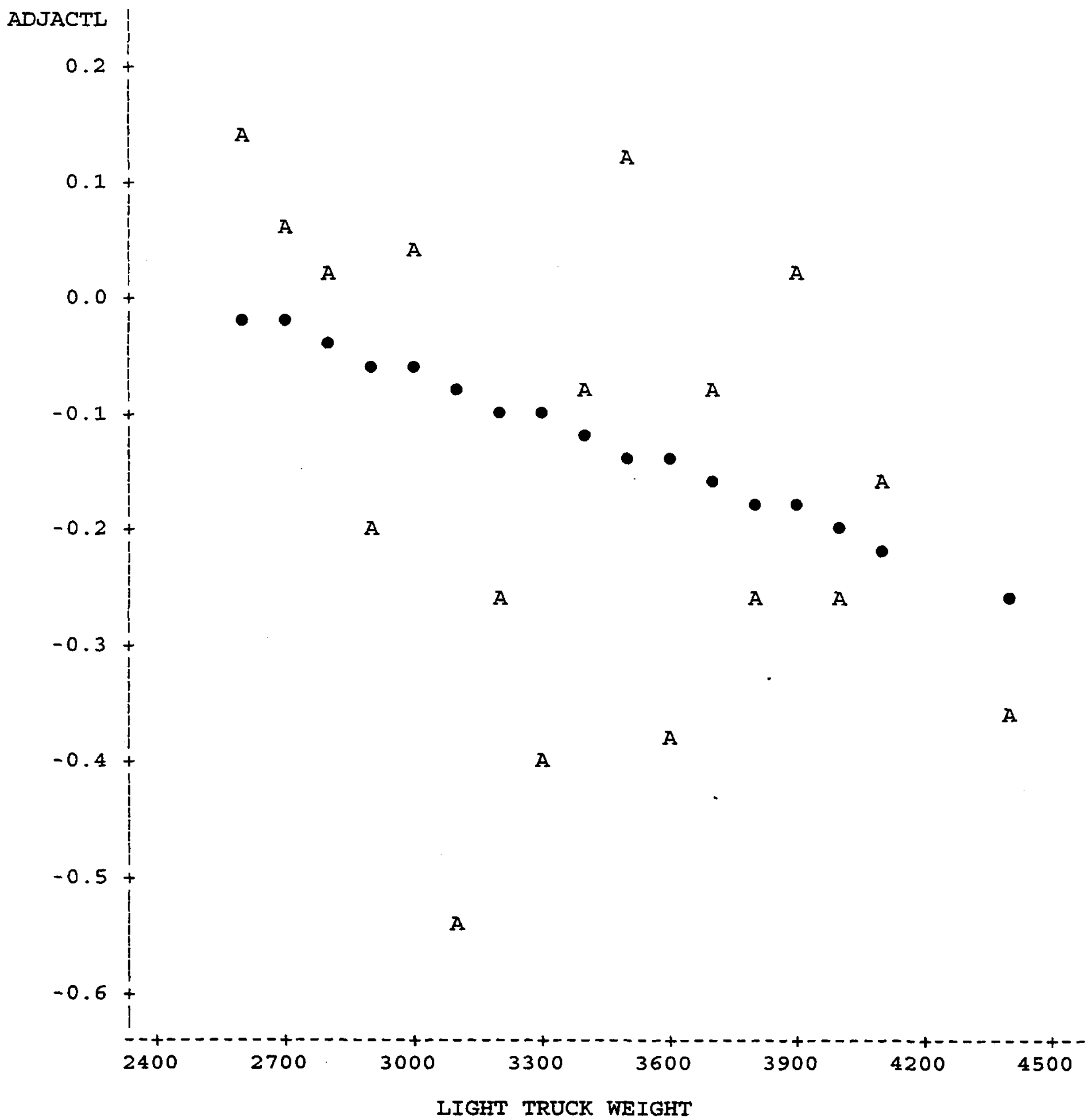


FIGURE 6-8: LIGHT TRUCK COLLISIONS WITH FIXED OBJECTS
FATALITY RISK BY VEHICLE WEIGHT

(After adjustment for all other control variables; excluding sporty SUVs)

A = actual rate; • = rate predicted by the model

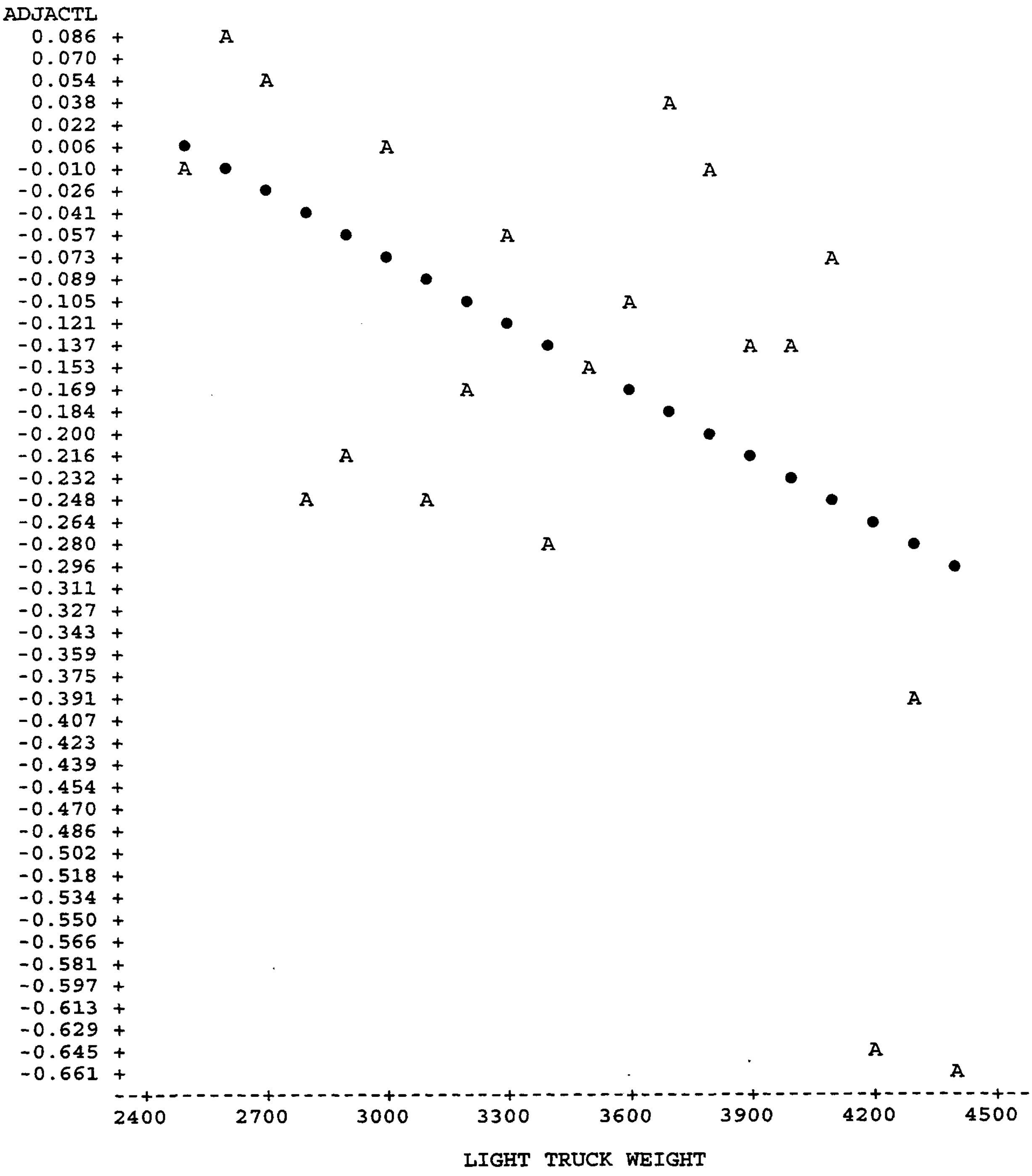


Figure 6-9 indicates a strong trend of increasing fatality risk for pedestrians, bicyclists and motorcyclists as the weight of light trucks increases. The linear fit is quite good, and there is no discernable pattern in the residuals.

Figure 6-10, with somewhat more sampling error, shows a clear tendency toward lower fatality risk, as the weight of the light truck increases, in the collisions of light trucks with big trucks. The linear fit is adequate.

Figure 6-11 shows an excellent linear fit. As the weight of light trucks increases, so does the fatality risk in collisions of light trucks with cars (most of the fatalities being car occupants). Except for two or three outliers, most of the actual fatality rates are close to the trend line.

In Figure 6-12, the actual data points for collisions between two light trucks are scattered without any discernable pattern, consistent with the regression analysis that did not show a significant weight-safety effect in those collisions.

In summary, none of the figures showed a weight-safety effect that became weaker toward the heavy end of the vehicle spectrum, or any other obvious nonlinear trend that would contraindicate the linear model used throughout this report. In all cases, the weight-safety effect was either reasonably uniform (a constant percentage change per 100-pound weight reduction) or it was close to zero.

6.7 Sensitivity tests: concentrating the weight reductions on the heaviest vehicles

We have stated that even with equal **percentage** changes in fatality risk per 100-pound weight reduction in large cars or small cars, the **absolute** change will be larger in the small cars. Since large cars have lower fatality risk than small cars, a 1 percent increase among the large cars is a smaller absolute number of fatalities than a 1 percent increase among the small cars. Table 6-12 provides a rather extreme sensitivity test for this effect by examining what happens if the entire weight reduction were to be applied to the heaviest 20 percent of cars on the road (those weighing 3262 pounds or more, in the MY 1985-93 fleet): if these cars were to be reduced by 500 pounds (and the other 80 percent of cars left unchanged), rather than all cars on the road being reduced by 100 pounds.

The baseline model estimated that if all cars were reduced by 100 pounds, rollover fatalities would increase by 80. Table 6-13 indicates that the rollover fatality rate, per million car years, among cars weighing 3262 pounds or more is only 55 percent as high as the aggregate fatality rate for all cars on the road. (The fatality rate is lower in the heavy cars partly because their size makes them less rollover-prone, partly because their drivers are less likely to exhibit behavior that leads to rollover crashes.) Thus, if the entire weight reduction were applied to those cars, the fatality increase would only be 55 percent as much - viz., 44 fatalities. A similar effect, but to a lesser extent, will occur in collisions with fixed objects, pedestrians, heavy trucks and light trucks. Car-to-car collisions have not been included in Table 6-13 because the baseline weight-safety effect was nonsignificant and because the simple computational method, as described above, cannot be applied. Excluding car-to-car collisions, Table 6-13 shows that the baseline

FIGURE 6-9

LIGHT TRUCK COLLISIONS WITH PEDESTRIANS, BICYCLISTS AND MOTORCYCLISTS: FATALITY RISK BY LIGHT TRUCK WEIGHT

(After adjustment for all other control variables; excluding sporty SUVs)

A = actual rate; ● = rate predicted by the model

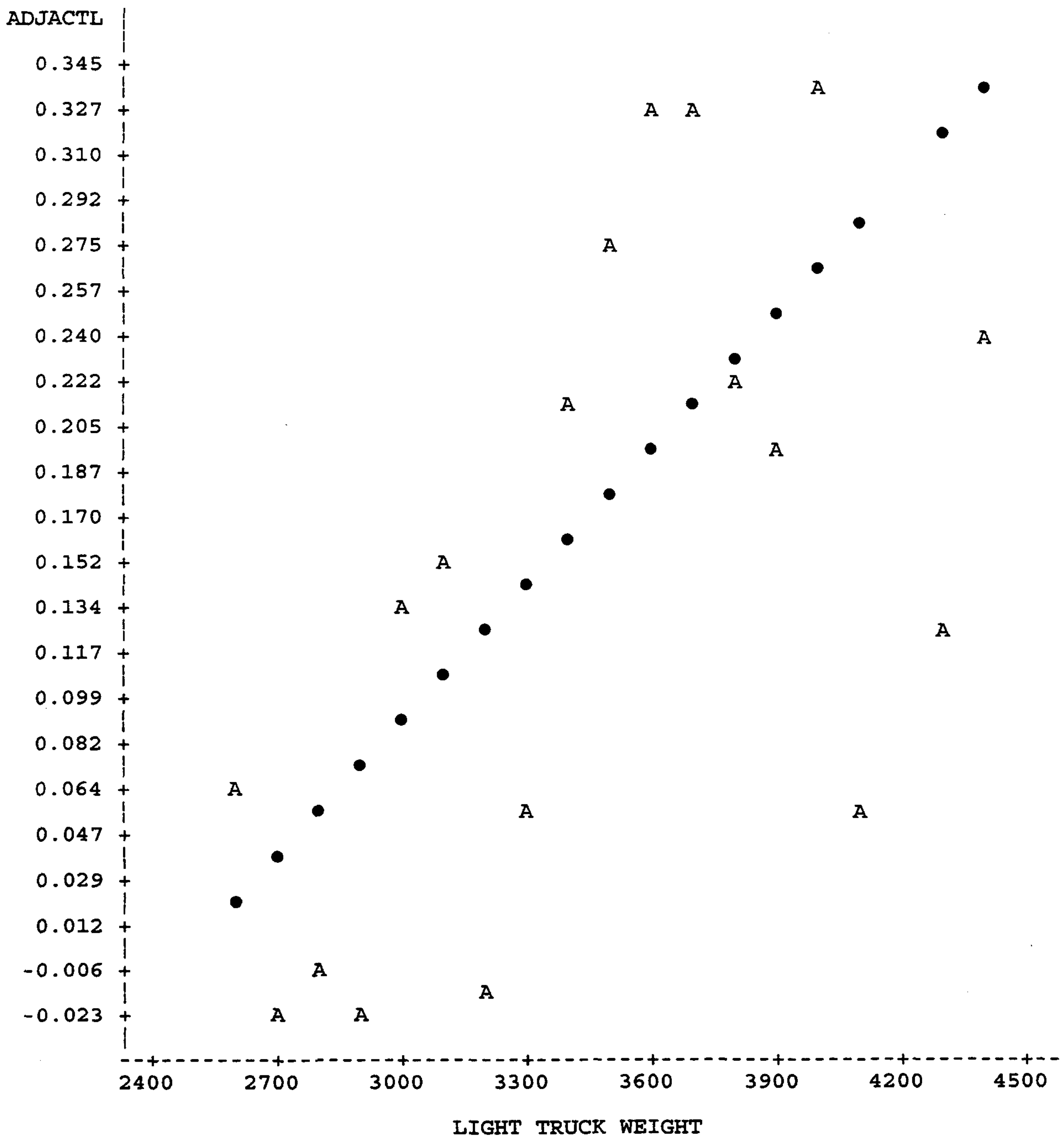


FIGURE 6-10

LIGHT TRUCK COLLISIONS WITH HEAVY TRUCKS
FATALITY RISK BY LIGHT TRUCK WEIGHT

(After adjustment for all other control variables; excluding sporty SUVs)

A = actual rate; ● = rate predicted by the model

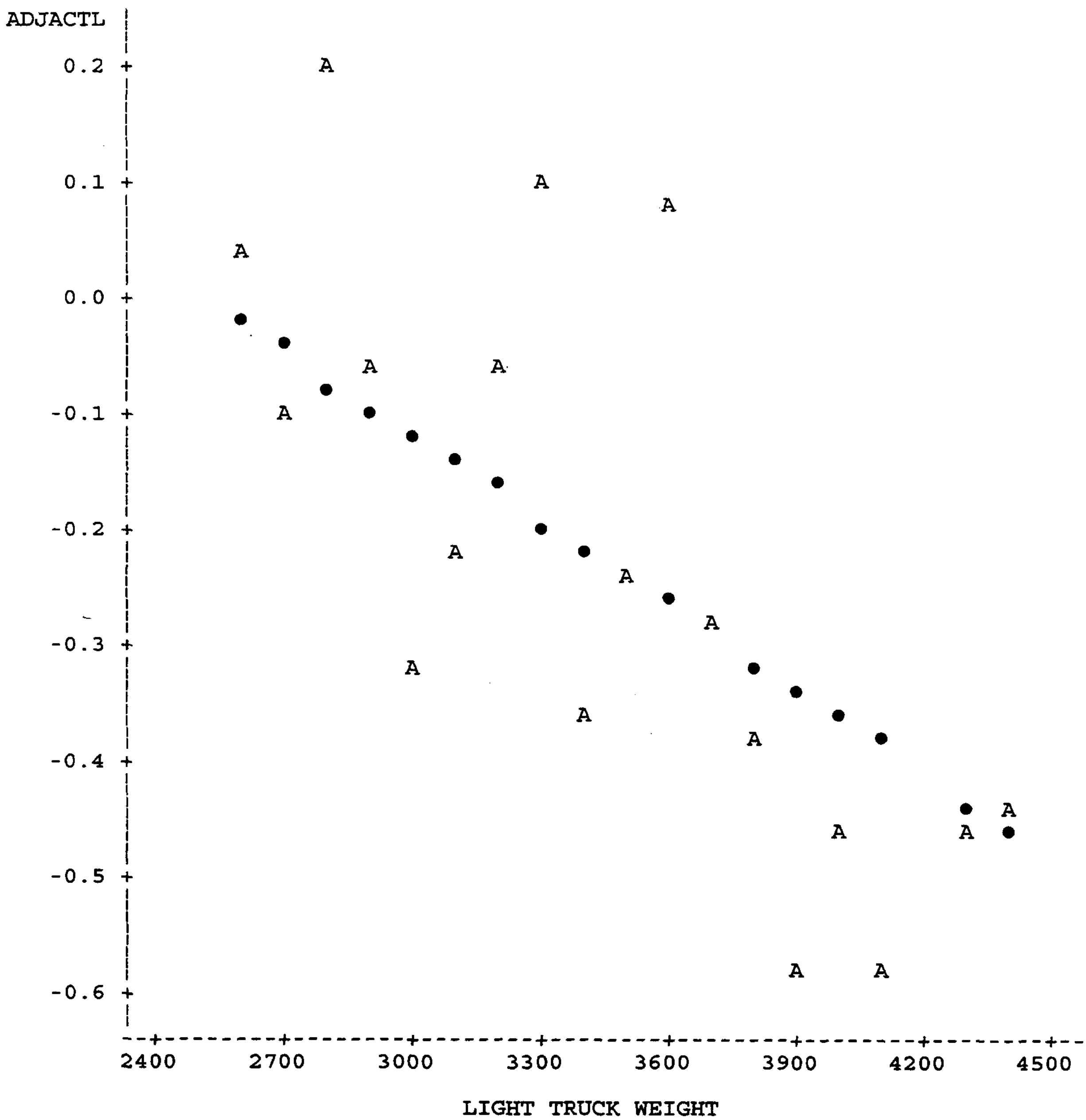


FIGURE 6-11

LIGHT TRUCK COLLISIONS WITH PASSENGER CARS
FATALITY RISK BY LIGHT TRUCK WEIGHT

(After adjustment for all other control variables; excluding sporty SUVs)

A = actual rate; ● = rate predicted by the model

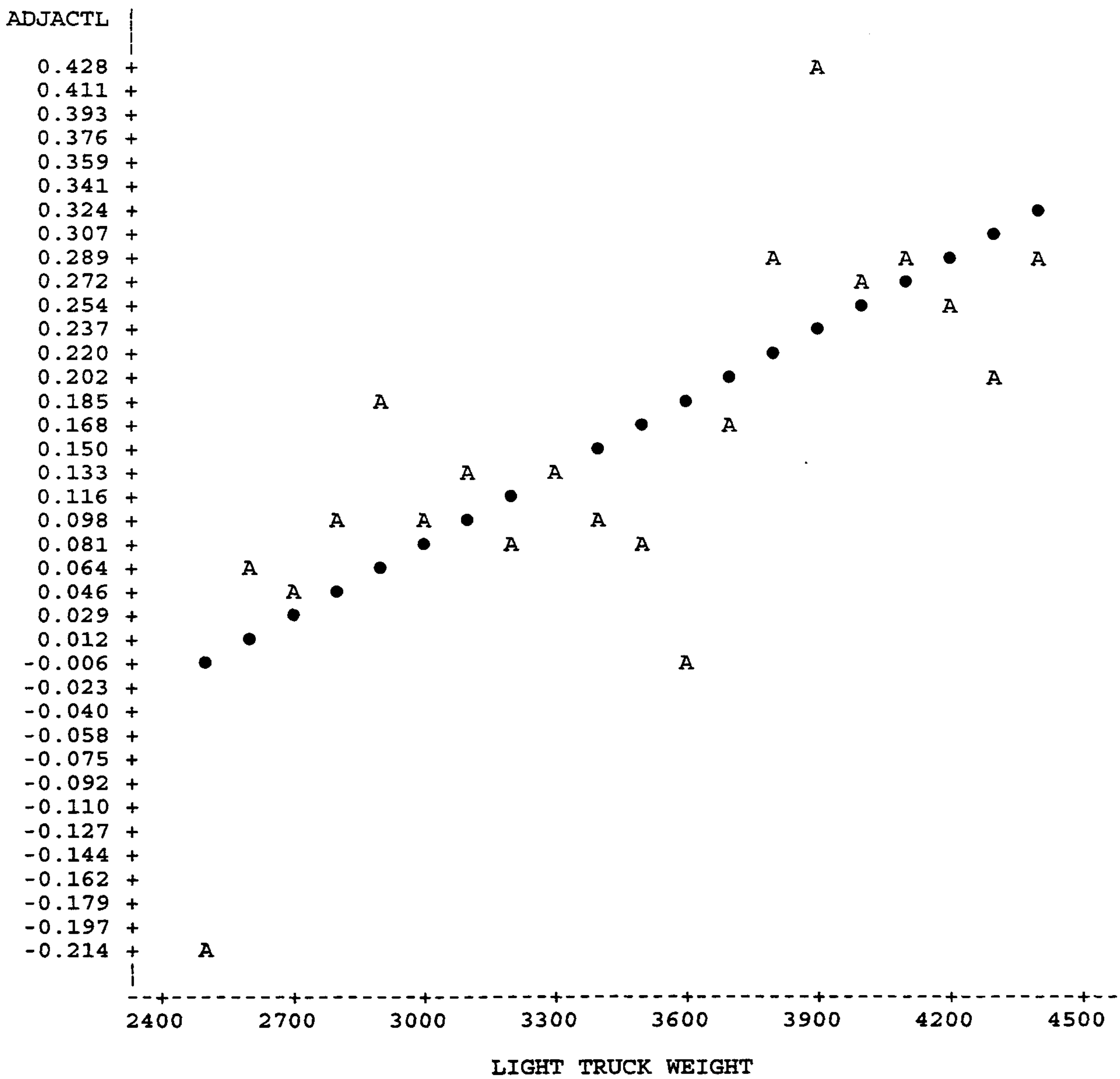


FIGURE 6-12

COLLISIONS BETWEEN TWO LIGHT TRUCKS
FATALITY RISK BY CASE VEHICLE WEIGHT

(After adjustment for all other control variables; excluding sporty SUVs)

A = actual rate; ● = rate predicted by the model

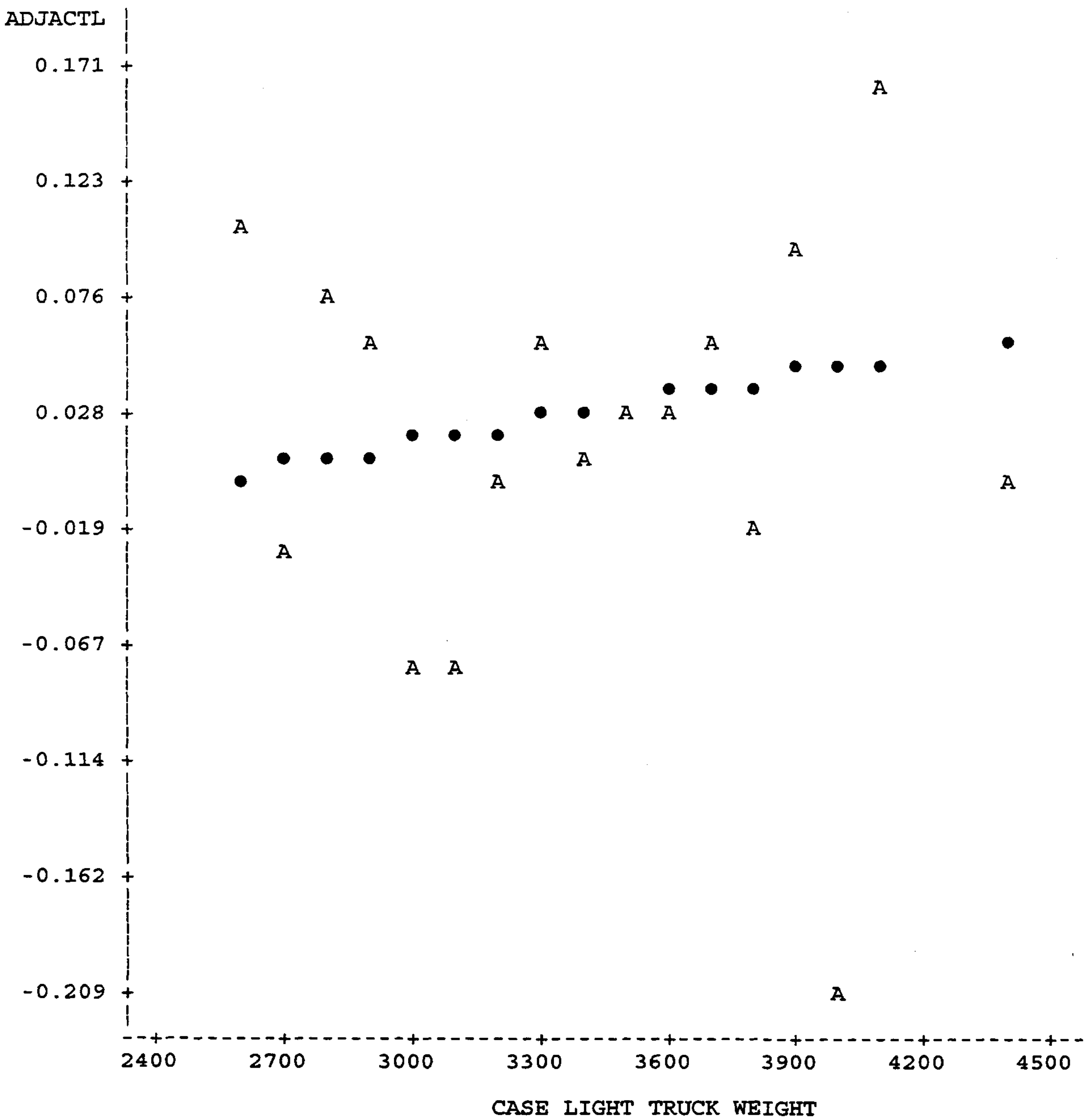


TABLE 6-13

PASSENGER CARS: SENSITIVITY TEST - CONCENTRATING THE WEIGHT REDUCTIONS ON THE HEAVIEST 20 PERCENT OF THE CARS

(excluding car-to-car collisions)

Crash Type	Baseline Fatality Change: All Cars Reduced 100 Pounds	Fatality Rate in Heaviest 20% / Fatality Rate in All Cars	Fatality Change: Heaviest 20% of Cars Reduced 500 Pounds
Principal rollover	+80	.55	+44
Hit fixed object	+84	.74	+62
Hit ped/bike/motorcycle	- 19	.94	- 18
Hit big truck	+37	.93	+35
Hit light truck	+151	.83	+125
TOTAL (excluding car-to-car)	**+333**		**+248**

model predicts an increase of 333 fatalities (in the other 5 crash types) if all cars are reduced by 100 pounds. But the increase is only 248 if the heaviest 20 percent of cars are reduced by 500 pounds and the others are left alone. That is a substantial mitigation of the fatality increase. Nevertheless, even this new estimate is within the 3-sigma confidence bounds of the baseline model excluding car-to-car collisions (point estimate 333, one standard deviation 36.4, 3σ bounds +223 to +443).

Similarly, Table 6-14 shows that concentrating the weight reduction among the heaviest 20 percent of light trucks on the road during 1989-93 (those weighing 3909 pounds or more) would have a beneficial societal effect in every type of crash. Wherever truck weight reductions are expected to result in societal savings (collisions with pedestrians and cars), the heaviest light trucks have higher-than-average fatality rates, and where weight reductions are associated with increased risk (rollovers, fixed objects, collisions with big trucks), the heaviest light trucks have lower-than-average risk. For example, the baseline model estimated that if all light trucks were reduced by 100 pounds, rollover fatalities would increase by 15. Table 6-14 indicates that the rollover fatality rate, per million years, among light trucks weighing 3909 pounds or more is only 89 percent as high as the rate for all light trucks on the road. Thus, if the entire weight reduction is applied to those trucks, the fatality increase would only be 13. Excluding collisions between two light trucks, Table 6-14 shows that the baseline model predicts a decrease of 34 fatalities (in the other 5 crash types) if all light trucks are reduced by 100 pounds. But the decrease could escalate to 65 if the heaviest 20 percent of cars are reduced by 500 pounds and the others are left alone. Nevertheless, this new estimate is within the 2σ confidence bounds of the baseline model excluding collisions between two light trucks (point estimate -34, one standard deviation 28.2, 2σ bounds -91 to +23).

TABLE 6-14

LIGHT TRUCKS: SENSITIVITY TEST - CONCENTRATING THE WEIGHT REDUCTIONS ON THE HEAVIEST 20 PERCENT OF THE TRUCKS

(excluding light truck-to-light truck collisions)

Crash Type	Baseline Fatality Change: All Trucks Reduced 100 Pounds	Fatality Rate in Heaviest 20% / Fatality Rate in All Trucks	Fatality Change: Heaviest 20% of Trucks Reduced 500 Pounds
Principal rollover	+15	.89	+13
Hit fixed object	+47	.88	+41
Hit ped/bike/motorcycle	- 45	1.06	- 47
Hit big truck	+29	.82	+24
Hit passenger car	- 80	1.20	- 96
TOTAL (excluding LT-to-LT)	**- 34**		**- 65**

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APPENDIX A

VALID VIN1-VIN3 COMBINATIONS FOR 1981-93 VEHICLES
(occurring on 1989-93 FARS data)

VIN	‡	VEHICLE TYPE
10T		OSHKOSH US HEAVY TRUCK
17N		UNKNOWN US HEAVY TRUCK, VINA_MOD=TPA, MY=89
1AC*		AMC EAGLE CAR US 81-83
1AC*	AM	EAGLE PREMIER CAR US 88
1AM		AMC/RENAULT US CAR 81-83
1B3	BE	DODGE US CAR
1B4*	TD	DODGE RAMCHARGER US SUV V5=D,W(81-88);E,M(89-93)
1B4*	TD	DODGE US VAN V5=B,K
1B5		DODGE US VAN-BUS
1B6*	TD	DODGE US PICKUP V4 NE M V5=D,N,R,W(81-88);E,G,L,M(89-93)
1B6*	TD	DODGE US VAN (INCOMPLETE) V5=B,K
1B6*		DODGE US HEAVY PICKUP V4=M V5=D,W(81-88);E,M(89-93)
1B7*	TD	DODGE US PICKUP V4 NE M V5=D,N,R,W(81-88);E,G,L,M(89-93)
1B7*	TD	DODGE RAMPAGE US PICKUP-CAR 82-84 V5=Z
1B7*	TD	DODGE US VAN (CARGO) V5=B,K
1B7*		DODGE US HEAVY PICKUP V4=M V5=D,W(81-88);E,M(89-93)
1C3	BC	CHRYSLER US CAR
1C4	UA	CHRYSLER TOWN&COUNTRY VAN US
1FA	CF	FORD US CAR
1FB*	TE	FORD US VAN-BUS GVW LE 10,000 V4=A-J
1FB*		FORD US VAN-BUS GVW GT 10,000 V4=K-Z
1FC*		FORD US STRIPPED CHASSIS GVW LE 10,000 V4=A-J
1FC*		FORD US STRIPPED CHASSIS GVW GT 10,000 V4=K-Z
1FD*	TE	FORD US INCOMPLETE PICKUP V4=A-J V5=F,R,W,X V6=1-3
1FD*		FORD US HEAVY TRUCK/BUS V4=K-Z(ALWAYS) V6=5-9(USUALLY)
1FD*	TE	FORD US INCOMPLETE VAN V4=A-J V5=A,E,S V6=1-4
1FF		FORD US HEAVY TRUCK (GLIDER KIT)
1FM*	TE	FORD US SUV V4=A-J V5=U V6=1-3
1FM*		FORD US HEAVY VAN V4=K-Z
1FM*	TE	FORD US PASSENGER VAN V4=A-J V5=A,E,S V6=1-4
1FT*	TE	FORD US PICKUP V4=A-J V5=F,R,W,X V6=1-3
1FT*		FORD US HEAVY TRUCK V4=K-Z (ALWAYS) V6=5-9 (USUALLY)
1FT*	TE	FORD US VAN V4=A-J V5=A,E,S V6=1-4
1FU		FREIGHTLINER US HEAVY TRUCK
1FV		FREIGHTLINER US HEAVY TRUCK
1G0*	TF	GMC US VAN-BUS (GVW LE 10000) V4=B-H
1G0*		GMC US HEAVY VAN-BUS (GVW GT 10000) V4=J-K
1G1	DD	CHEVROLET US CAR
1G2	DP	PONTIAC US CAR

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
* More than one type of vehicle with this VIN
** 2 or more Polk MAKE_ABR codes for this VIN (see Vehicle Type)

VIN	‡	VEHICLE TYPE
1G3	DO	OLDSMOBILE US CAR
1G4	DB	BUICK US CAR
1G5*	TF	GMC US SUV 81-86 V4=B-H V5=C,K,S,T V7=6,8
1G5*	TF	GMC US VAN 81-86 V4=B-H V5=G,M V7=5,9
1G5		PONTIAC US INCOMPLETE CAR 89-93 (RARE IN US)
1G6	DC	CADILLAC US CAR
1G7		PONTIAC US CAR FOR CANADIAN MARKET (RARE IN US)
1G8*	TA	CHEVROLET US SUV 81-86 V4=B-H V5=C,K,S,T V7=6,8
1G8*	TA	CHEVROLET US VAN 81-86 V4=B-H V5=G,M V7=5,9
1G8*	DR	SATURN US CAR 91-93 V4=Z
1GA*	TA	CHEVROLET US VAN-BUS (GVW LE 10000) V4=B-H
1GA*		CHEVROLET US HEAVY VAN-BUS (GVW GT 10000) V4=J-K
1GB*	TA	CHEVROLET US PICKUP V4=B-H V5=C,D,K,R,S,T,V V7=3,4,9
1GB*	TA	CHEVROLET US SUV V4=B-H V5=C,K,R,S,T,V V7=6,8
1GB*	TA	CHEVROLET US VAN V4=B-H V5=G,L,M,P V7=5,9
1GB*		CHEVROLET US HEAVY PICKUP V4=J-K V5=C,K,R,S,T,V
1GB*		CHEVROLET US HEAVY VAN V4=J-K V5=G,L,M,P
1GB*		CHEVROLET US HEAVY TRUCK V5=4-9 V6 NE P,S
1GB*		CHEVROLET US BUS V5=4-9 V6=P,S
1GC*	TA	CHEVROLET US PICKUP V4=B-H V5=C,D,K,R,S,T,V V7=3,4,9
1GC*	TA	CHEVROLET US SUV V4=B-H V5=C,K,R,S,T,V V7=6,8
1GC*	TA	CHEVROLET US VAN V4=B-H V5=G,L,M,P V7=5,9
1GC*	TA	CHEVROLET EL CAMINO US PICKUP-CAR 81-84 V5=W
1GC*		CHEVROLET US HEAVY PICKUP V4=J-K V5=C,K,R,S,T,V
1GC*		CHEVROLET US HEAVY VAN V4=J-K V5=G,L,M,P
1GC*		CHEVROLET US HEAVY TRUCK V5=4-9
1GD*	TF	GMC US PICKUP V4=B-H V5=C,D,K,R,S,T,V V7=3,4,9
1GD*	TF	GMC US SUV V4=B-H V5=C,K,R,S,T,V V7=6,8
1GD*	TF	GMC US VAN V4=B-H V5=G,L,M,P V7=5,9
1GD*	TF	GMC CABALLERO US PICKUP-CAR 81-84 V5=W
1GD*		GMC US HEAVY PICKUP V4=J-K V5=C,K,R,S,T,V
1GD*		GMC US HEAVY VAN V4=J-K V5=G,L,M,P
1GD*		GMC US HEAVY TRUCK V5=4-9 V6 NE P,S
1GD*		GMC US BUS V5=4-9 V6=P,S
1GF		US TRANSIT BUS (make unknown)
1GH	UB	OLDSMOBILE SILHOUETTE/BRAVADA US VAN/SUV
1GJ*	TF	GMC US VAN-BUS (GVW LE 10000) V4=B-H
1GJ*		GMC US HEAVY VAN-BUS (GVW GT 10000) V4=J-K
1GK*	TF	GMC US SUV 87-93 V4=B-H V5=C,K,R,S,T,V V7=6,8
1GK*	TF	GMC US VAN 87-93 V4=B-H V5=G,L,M,P V7=5,9
1GM	UC	PONTIAC TRANS SPORT US VAN
1GN*	TA	CHEVROLET US SUV 87-93 V4=B-H V5=C,K,R,S,T,V V7=6,8
1GN*	TA	CHEVROLET US VAN 87-93 V4=B-H V5=G,L,M,P V7=5,9
1GT*	TF	GMC US PICKUP V4=B-H V5=C,D,K,R,S,T,V V7=3,4,9
1GT*	TF	GMC US SUV V4=B-H V5=C,K,R,S,T,V V7=6,8
1GT*	TF	GMC US VAN V4=B-H V5=G,L,M,P V7=5,9
1GT*	TF	GMC CABALLERO US PICKUP-CAR 81-84 V5=W
1GT*		GMC US HEAVY PICKUP V4=J-K V5=C,K,R,S,T,V

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
* More than one type of vehicle with this VIN
** 2 or more Polk MAKE_ABR codes for this VIN (see Vehicle Type)

VIN	‡	VEHICLE TYPE
1GT*		GMC US HEAVY VAN V4=J-K V5=G,L,M,P
1GT*		GMC US HEAVY TRUCK V5=4-9
1HD		HARLEY-DAVIDSON US MOTORCYCLE
1HF		HONDA US MOTORCYCLE
1HG	IS	HONDA US CAR
1HS		NAVISTAR/INTERNATIONAL US HEAVY TRUCK
1HT		NAVISTAR/INTERNATIONAL US HEAVY TRUCK
1HT		NAVISTAR/INTERNATIONAL US BUS
1HV		NAVISTAR/INTERNATIONAL US SCHOOL BUS
1J4	TH	JEEP US SUV 89-93
1J7	TH	JEEP COMANCHE US PICKUP 89-93
1JC	TH	JEEP US SUV 81-88
1JT*	TH	JEEP US PICKUP 81-88 V6=2,6
1JT*	TH	JEEP US SUV 81-88 V6 NE 2,6
1JV		MARMON US HEAVY TRUCK
1LJ		LINCOLN US LIMOUSINE
1LN	CL	LINCOLN US CAR
1M1		MACK US HEAVY TRUCK
1M2		MACK US HEAVY TRUCK
1M3		MACK US HEAVY TRUCK
1MB		MERCEDES-BENZ US HEAVY TRUCK
1ME	CM	MERCURY US CAR
1MR	CL	LINCOLN MARK/CONTL US CAR 81-86
1N4	IN	NISSAN US CAR
1N6	WA	NISSAN US PICKUP TRUCK
1NK		KENWORTH US HEAVY TRUCK
1NX	JN	NUMMI TOYOTA COROLLA US CAR
1P3	BP	PLYMOUTH US CAR
1P4*		PLYMOUTH TRAILDUSTER US SUV 81-82
1P4*	TL	PLYMOUTH GRAND VOYAGER US VAN 87-93
1P7		PLYMOUTH SCAMP US PICKUP-CAR 82-84
1TU		US TRANSIT BUS (make unknown)
1V1		VW RABBIT PICKUP-CAR US 81-83
1VW	JQ	VW US CAR
1WA		AUTOCAR US HEAVY TRUCK 81-88
1WB		AUTOCAR US HEAVY TRUCK (INCOMPLETE) 81-88
1WD		AUTOCAR US HEAVY TRUCK (GLIDER KIT) 81-88
1WK		WESTERN STAR US HEAVY TRUCK 81-84
1WL		WESTERN STAR US HEAVY TRUCK (INCOMPLETE) 81-84
1WM		WESTERN STAR US HEAVY TRUCK (GLIDER KIT) 81-84
1WU		WHITE US HEAVY TRUCK 81-88
1WW		UNKNOWN US HEAVY TRUCKS, VINA_MOD=S/P, MY=84-87
1WX		WHITE US HEAVY TRUCK (INCOMPLETE) 81-88
1WY		WHITE US HEAVY TRUCK (GLIDER KIT) 81-88
1XK		KENWORTH US HEAVY TRUCK
1XM	AM	RENAULT ALLIANCE-ENCORE US CAR
1XP		PETERBILT US HEAVY TRUCK
1Y1	KE	NUMMI CAR (NOVA/PRIZM) US

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
* More than one type of vehicle with this VIN
** 2 or more Polk MAKE_ABR codes for this VIN (see Vehicle Type)

VIN	‡	VEHICLE TYPE
1YV	IW	MAZDA US CAR
1ZV	CF	FORD PROBE US CAR
2A3		IMPERIAL CANADA PRE-85 CAR
2B3	BE	DODGE CANADA CAR
2B4*	TD	DODGE CANADA VAN (GVW LE 10000) V4=D-L
2B4*		DODGE CANADA HEAVY VAN (GVW GT 10000) V4=M
2B5	TD	DODGE CANADA VAN-BUS
2B6	TD	DODGE CANADA VAN (INCOMPLETE)
2B7	TD	DODGE CANADA VAN
2BC	TH	JEEP CANADA SUV 87-88
2C1	KE	GEO METRO CANADA CAR
2C3	BC	CHRYSLER CANADA CAR
2CC	AM	AMC EAGLE CANADA CAR 81-88
2CM		AMC CANADA PRE-85 CAR
2CN	TA	CAMI GEO TRACKER CANADA SUV 90-93
2E3	AM	EAGLE CANADA CAR 89-93
2FA	CF	FORD CANADA CAR
2FB*		FORD CANADA VAN-BUS 81 GVW LE 10,000 V4=A-J
2FB*		FORD CANADA VAN-BUS 81 GVW GT 10,000 V4=K-Z
2FD*	TE	FORD CANADA INCOMPLETE PICKUP V4=A-J V5=F,X V6=1-4
2FD*		FORD CANADA HEAVY PICKUP V4=K-Z
2FT*	TE	FORD CANADA PICKUP V4=A-J V5=F,R,W,X V6=1-3
2FT*		FORD CANADA HEAVY PICKUP/VAN V4=K-Z
2FT*		FORD CANADA VAN 81-82 V4=A-J V5=E,S V6=1-3
2FU		FREIGHTLINER CANADA HEAVY TRUCK
2FV		FREIGHTLINER CANADA HEAVY TRUCK
2G0*	TF	GMC CANADA VAN-BUS (GVW LE 10000) V4=B-H
2G0*		GMC CANADA HEAVY VAN-BUS (GVW GT 10000) V4=J-K
2G1	DD	CHEVROLET CANADA CAR
2G2	DP	PONTIAC CANADA CAR
2G3	DO	OLDSMOBILE CANADA CAR
2G4	DB	BUICK CANADA CAR
2G5	TF	GMC CANADA VAN 81-86
2G7		PONTIAC CANADA PRE-85 CAR
2G8	TA	CHEVROLET CANADA VAN 81-86
2GA*	TA	CHEVROLET CANADA VAN-BUS (GVW LE 10000) V4=B-H
2GA*		CHEVROLET CANADA HEAVY VAN-BUS (GVW GT 10000) V4=J-K
2GB*	TA	CHEVROLET CANADA PICKUP V4=B-H V5=C,K,R,S,T,V
2GB*	TA	CHEVROLET CANADA VAN V4=B-H V5=G,P V7=5,9
2GB*		CHEVROLET CANADA HEAVY PICKUP V4=J-K V5=C,K,R,S,T,V
2GB*		CHEVROLET CANADA HEAVY VAN V4=J-K V5=G,P
2GC*	TA	CHEVROLET CANADA PICKUP V4=B-H V5=C,D,K,R,S,T,V
2GC*	TA	CHEVROLET CANADA VAN V4=B-H V5=G,H,P V7=5,9
2GC*		CHEVROLET CANADA HEAVY PICKUP V4=J-K V5=C,K,R,S,T,V
2GC*		CHEVROLET CANADA HEAVY VAN V4=J-K V5=G,H,P
2GD*	TF	GMC CANADA PICKUP V4=B-H V5=C,D,K,R,S,T,V
2GD*	TF	GMC CANADA VAN V4=B-H V5=G,P V7=5,9
2GD*		GMC CANADA HEAVY PICKUP V4=J-K V5=C,K,R,V

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
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VIN	‡	VEHICLE TYPE
2GD*		GMC CANADA HEAVY VAN V4=J-K V5=G,P
2GD*		GMC CANADA HEAVY TRUCK V5=4-9
2GJ*	TF	GMC CANADA VAN-BUS (GVW LE 10000) V4=B-H
2GJ*		GMC CANADA HEAVY VAN-BUS (GVW GT 10000) V4=J-K
2GK	TF	GMC SPORTVAN CANADA VAN 87-93
2GN	TA	CHEVROLET SPORTVAN CANADA VAN 87-93
2GT*	TF	GMC CANADA PICKUP V4=B-H V5=C,K,R,V
2GT*	TF	GMC CANADA VAN V4=B-H V5=G
2GT*		GMC CANADA HEAVY VAN V4=J,K V5=G V7=1
2HG	IS	HONDA CIVIC CANADA CAR
2HM	KI	HYUNDAI SONATA CANADA CAR
2HS		NAVISTAR/INTERNATIONAL CANADA HEAVY TRUCK
2HT		NAVISTAR/INTERNATIONAL CANADA HEAVY TRUCK
2HT		NAVISTAR/INTERNATIONAL CANADA BUS
2J4	TH	JEEP WRANGLER CANADA SUV 89-93
2M1		MACK CANADA HEAVY TRUCK
2M2		MACK CANADA HEAVY TRUCK
2ME	CM	MERCURY CANADA CAR
2NK		KENWORTH CANADA HEAVY TRUCK
2P3		PLYMOUTH GRAN FURY CANADA CAR 82-83
2P4	TL	PLYMOUTH VOYAGER CANADA VAN
2P5		PLYMOUTH CANADA VAN-BUS 81-83
2S2	KS	SUZUKI SWIFT CANADA CAR 91-93
2S3	WU	SUZUKI SIDEKICK CANADA SUV 90-93
2T1	JN	TOYOTA COROLLA CANADA CAR 90-93
2WK		WESTERN CANADA HEAVY TRUCK
2WL		WESTERN CANADA HEAVY TRUCK (INCOMPLETE)
2WM		WESTERN CANADA HEAVY TRUCK (GLIDER KIT)
2XK		KENWORTH CANADA HEAVY TRUCK
2XM	AM	EAGLE PREMIER 88 CANADA CAR
3B3	BE	DODGE MEXICO CAR
3B4*	TD	DODGE RAMCHARGER MEXICO SUV V5=D,W(81-88);E,M(89-93)
3B7	TD	DODGE MEXICO D/W PICKUP 90-93
3C3	BC	CHRYSLER MEXICO CAR
3FA	CF	FORD MEXICO CAR 91-93
3FC		FORD MEXICO HEAVY TRUCK V6=5-9
3NM		KENWORTH MEXICO HEAVY TRUCK
3G1	DD	CHEVROLET MEXICO CAR
3G4	DB	BUICK MEXICO CAR
3GC	TA	CHEVROLET EL CAMINO MEXICO PICKUP-CAR
3GT	TF	GMC CABALLERO MEXICO PICKUP-CAR
3H1		HONDA MEXICO MOTORCYCLE
3MA	CM	MERCURY TRACER MEXICO
3N1		NISSAN MEXICO CAR
3P3	BP	PLYMOUTH MEXICO CAR
3VW	JQ	VW MEXICO CAR 89-93

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
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VIN	‡	VEHICLE TYPE
478		HONDA US ATV
4A3	KA	MITSUBISHI DIAMOND-STAR US CAR 90-93
4CD		GRUMMAN US HEAVY TRUCK OR BUS
4E3	**	EAGLE DIAMOND-STAR CAR US 90-93 (AM,KP)
4F2	WB	MAZDA NAVAJO US SUV 91-93
4GD		GMC OR VOLVO-GMC US HEAVY TRUCK 88-89
4GT		GMC OR VOLVO-GMC US HEAVY TRUCK 88-89
4M2	UD	MERCURY VILLAGER US VAN 93
4N2	WA	NISSAN QUEST US VAN 93
4P3	BP	PLYMOUTH DIAMOND-STAR CAR US 90-93
4S1	WD	ISUZU US PICKUP 90-93
4S2	WD	ISUZU RODEO US SUV 91-93
4S3	JK	SUBARU US CAR (LEGACY) 90-93
4S4	JK	SUBARU US 4WD CAR (LEGACY) 90-93
4T1	JN	TOYOTA CAMRY US CAR
4TA	WD	TOYOTA US PICKUP 92-93
4V1		WHITEGMC US HEAVY TRUCK
4V2		WHITEGMC US HEAVY TRUCK
4V3		WHITEGMC US HEAVY TRUCK
4V5		VOLVO(?) US HEAVY TRUCK
6MM	KA	MITSUBISHI DIAMANTE AUSTRALIA CAR
6MP	KL	MERCURY CAPRI AUSTRALIA CAR
9BF		FORD BRAZIL HEAVY TRUCK
9BW	JQ	VW FOX BRAZIL CAR
9C2		HONDA BRAZIL MOTORCYCLE
9C6		YAMAHA BRAZIL MOTORCYCLE
9DB		MERCEDES BRAZIL PRE-1985 CAR
J81	KE	CHEVROLET SPECTRUM/GEO STORM JAPAN CAR
JG7		PONTIAC JAPAN CAR FOR CANADIAN MARKET (RARE IN US)
J8B		CHEVROLET-ISUZU JAPAN HEAVY TRUCK
J8D		GMC-ISUZU JAPAN HEAVY TRUCK
J8Z		CHEVROLET LUV PICKUP JAPAN 81-83
JA3	KA	MITSUBISHI JAPAN CAR
JA4*	WT	MITSUBISHI MONTERO JAPAN SUV V5=J(84-91),K(92),R(93)
JA4*	WT	MITSUBISHI JAPAN VAN 87-90 V5=N
JA7*	WT	MITSUBISHI JAPAN PICKUP V5=K,P(83-87);M,L(87-92);S,T(93)
JA7*	WT	MITSUBISHI MONTERO JAPAN SUV V5=J(84-91),K(92),R(93)
JA7*	WT	MITSUBISHI JAPAN VAN 87-90 V5=N
JAA*	WD	ISUZU JAPAN PICKUP V5=L,R AND V6 NE 0
JAA*	WD	ISUZU JAPAN SUV V5=G,H OR V6=0
JAB	JZ	ISUZU JAPAN CAR
JAC	WD	ISUZU JAPAN SUV
JAL		ISUZU JAPAN HEAVY TRUCK/BUS
JAM		ISUZU JAPAN HEAVY TRUCK (GVW 10,000-14,000)

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
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VIN	‡	VEHICLE TYPE
JB3	JX	DODGE JAPAN CAR
JB4	JX	DODGE COLT 4WD JAPAN CAR
JB7*	TD	DODGE JAPAN PICKUP V5 NE J
JB7*	TD	DODGE RAIDER JAPAN SUV 87-89 V5=J
JC2		FORD COURIER JAPAN PICKUP 81-82
JC4		FORD COURIER JAPAN PICKUP 81-82
JD1	KO	DAIHATSU JAPAN CAR
JD2	WZ	DAIHATSU ROCKY JAPAN SUV
JE3	KP	EAGLE JAPAN CAR 89-93
JF1	JK	SUBARU JAPAN CAR
JF2	JK	SUBARU JAPAN 4WD CAR EXCLUDE V5=T IN 81-85
JF2	WL	SUBARU BRAT 81-85 JAPAN CAR-BASED PICKUP V5=T
JF3	WL	SUBARU BRAT 86-87 JAPAN CAR-BASED PICKUP
JG1	KE	CHEVROLET SPRINT/GEO METRO JAPAN CAR
JGC	TA	CHEVROLET GEO TRACKER JAPAN SUV 89
JGT		GMC GEO TRACKER JAPAN SUV 89 (?)
JH2		HONDA JAPAN MOTORCYCLE
JH3		HONDA JAPAN ATV
JH4	KH	ACURA JAPAN CAR
JH6		HINO JAPAN HEAVY TRUCK
JHB		HINO JAPAN HEAVY TRUCK
JHM	IS	HONDA JAPAN CAR
JJ3	KK	CHRYSLER CONQUEST JAPAN CAR
JKA		KAWASAKI JAPAN MOTORCYCLE OR ATV
JKB		KAWASAKI JAPAN MOTORCYCLE OR ATV
JM1	IW	MAZDA JAPAN CAR
JM2	WB	MAZDA JAPAN PICKUP TRUCK
JM3	WB	MAZDA "MPV" JAPAN VAN
JN1*	IN	NISSAN JAPAN CAR
JN1*	IN	NISSAN AXXESS JAPAN VAN
JN6*	WA	NISSAN JAPAN PICKUP
JN6*	WA	NISSAN PATHFINDER JAPAN SUV 87 V7=4
JN8*	IN	NISSAN 4WD STANZA JAPAN CAR 86-89 V5=M
JN8*	WA	NISSAN PATHFINDER JAPAN SUV 87-93 V5=D V7=4
JN8*	WA	NISSAN JAPAN VAN 87-88 V5=C
JNA		NISSAN JAPAN HEAVY TRUCK
JNK	KR	INFINITI JAPAN CAR
JNX	KR	INFINITI JAPAN CONVERTIBLE CAR
JP3	KB	PLYMOUTH JAPAN CAR
JP4	KB	PLYMOUTH COLT 4WD JAPAN CAR 85-91
JP7		PLYMOUTH ARROW PICKUP JAPAN 81-82
JPA		NAVISTAR/INTERNATIONAL JAPAN HEAVY TRUCK
JS1		SUZUKI JAPAN MOTORCYCLE
JS2	KQ	SUZUKI JAPAN CAR 89-93
JS3	WU	SUZUKI JAPAN SUV
JS4	WU	SUZUKI JAPAN SUV
JSA		SUZUKI JAPAN ATV
JT2	JN	TOYOTA JAPAN CAR

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
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VIN	‡	VEHICLE TYPE
JT3*	WD	TOYOTA JAPAN SUV V5=J,N
JT3*	WD	TOYOTA JAPAN VAN V5=C,R
JT4*	WD	TOYOTA JAPAN PICKUP V5=D,N (EXCEPT N61,N62 SUV)
JT4*	WD	TOYOTA 4WD 4RUNNER JAPAN SUV V567=N61 IN 84-85, N62 IN 86-89
JT4*	WD	TOYOTA JAPAN VAN V5=R
JT5*	JN	TOYOTA CELICA CONVERTIBLE JAPAN CAR V5=A,T
JT5*	WD	TOYOTA JAPAN PICKUP (INCOMPLETE) V5=N
JT5*	WD	TOYOTA JAPAN VAN (INCOMPLETE) V5=R
JT8	KS	LEXUS JAPAN CAR
JW6		MITSUBISHI JAPAN HEAVY TRUCK 87-93
JY3		YAMAHA JAPAN ATV
JY4		YAMAHA JAPAN ATV
JYA		YAMAHA JAPAN MOTORCYCLE (+ A FEW MOTOCROSS ATV)
KL2	KM	PONTIAC LEMANS KOREA CAR
KM4		SUZUKI KOREA ATV
KMH	**	HYUNDAI (OR MITSUBISHI PRECIS) KOREA CAR
KNJ	JY	FORD FESTIVA KOREA CAR
KPH	KA	MITSUBISHI PRECIS KOREA CAR
LES	WS	ISUZU TROOPER TAIWAN SUV
LFA	KL	MERCURY TRACER TAIWAN CAR
LM1		SUZUKI TAIWAN ATV
SAJ	IT	JAGUAR GB CAR
SAX	KN	STERLING GB CAR
VF1	**	RENAULT/ALLIANCE/MEDALLION FRANCE CAR (AM,JF,KP)
VF3	JD	PEUGEOT FRANCE CAR
VG6		MACK LARGE TRUCK BY RENAULT FRANCE
VX1	KJ	YUGO YUGOSLAVIA CAR
WAU	ID	AUDI GERMANY CAR
WB1		BMW GERMANY MOTORCYCLE 82-93
WBA	IH	BMW GERMANY CAR
WBM		BMW GERMANY MOTORCYCLE 81
WBS	IH	BMW "M" CAR GERMANY
WDB	IX	MERCEDES GERMANY CAR
WF1	KG	MERKUR GERMANY CAR
WMD		MAGIRUS-IVECO GERMANY LARGE TRUCK
WP0	JE	PORSCHE GERMANY CAR
WV2	WE	VW GERMANY VAN
WVW	JQ	VW GERMANY CAR
YB3		VOLVO BELGIUM HEAVY TRUCK
YS3	JI	SAAB SWEDEN CAR
YV1	JR	VOLVO SWEDEN CAR

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
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VIN	‡ VEHICLE TYPE
YV2	VOLVO SWEDEN LARGE TRUCK
YV5	VOLVO SWEDEN LARGE TRUCK
ZAR	ALFA-ROMEO ITALY LOW-SALES-VOLUME CAR
ZBB	BERTONE ITALY LOW-SALES-VOLUME CAR
ZC2	TC BY MASERATI ITALY LOW-SALES-VOLUME CAR
ZCF	IVECO ITALY LARGE TRUCK (OCCASIONAL BUS)
ZFA	FIAT ITALY PRE-85 CAR

‡ Polk MAKE_ABR codes for 1985-93 passenger vehicles
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APPENDIX B

FUNDAMENTAL CAR GROUPS, 1985-93
(Shared Body Platforms)

(Excerpted from a 1968-94 list of fundamental car groups)

1. The first line of the definition assigns a four-digit number to the car group; the first two digits indicate the manufacturer, based on FARS codes (1=AMC, 6=Chrysler, 12=Ford, 18=GM, etc.); the last two digits are sequential and generally chronological for that manufacturer.

2. The second line assigns a name to the car group and gives the limits of the range of model years for the various make-models in the car group. Car groups are often named after the largest selling make-model with that body platform and/or the wheelbase of that platform (to the nearest inch).

3. The third line shows the wheelbase of the cars in that group, as derived from "New Car Specifications" in Automotive News.

4. The remaining lines list the specific make-models included in the car group, including the FARS four-digit make-model codes, the make-model name (plus additional specifications such as "4-door" if not every car of that make-model is in that car group during the specified time period), a range of model years, and the VIN characters that identify specifically which cars belong to this car group (V3 is the 3rd character of the VIN, V34 is the 3rd and 4th character, etc.).

American Motors Car Groups

Car group 111
AMC Eagle, 1985-88
Wheelbase 109.3
109 AMC Eagle, 1985-88 V6=3

Car group 112
AMC SX4, 1985-86
Wheelbase 97.2
110 AMC SX4/Kammback, 1985-86 V6=5

Chrysler Corp. Domestic Car Groups

Car group 614
5th Ave/Diplomat/Gran Fury, 1985-89
Wheelbase 112.7, sometimes written as 112.5
610 Chrysler 5th Avenue, 1985-88 V5=F V1=1 V7=6
610 Chrysler 5th Avenue, 1989 V5=M V1=1 V7=6
707 Dodge Diplomat 1985-88 V5=G V1=1 V7=6
707 Dodge Diplomat 1989 V5=M V1=1 V7=6
904 Plymouth Gran Fury, 1985-88 V5=B V1=1 V7=6
904 Plymouth Gran Fury, 1989 V5=M V1=1 V7=6

Car group 615
Omni/Horizon 4 door, 1985-90
Wheelbase 99.2, sometimes written as 99.1, 99.7
708 Dodge Omni 4 door, 1985-88 V5=Z V1=1 V7=8
708 Dodge Omni, 1989-90 V5=L V1=1 V7=8
908 Plymouth Horizon 4 door, 1985-88 V5=M V7=8
908 Plymouth Horizon, 1989-90 V5=L V1=1 V7=8

Car group 616
Omni/Horizon 2 door, 1985-87
Wheelbase 96.7, sometimes written as 96.6
708 Dodge Omni 2 door, 1985-87 V5=Z V1=1 V7=4
908 Plymouth Horizon 2 door, 1985-87 V5=M V1=1 V7=4

Car group 618
Aries/Reliant K, 1985-93
Wheelbase 99.6, sometimes varying up to 100.6
616 Chrysler LeBaron (except GTS, limo), 1985-88 V1=1,3 V5=C V6=4,5 V7 NE 2
616 Chrysler LeBaron (except GTS), 1987-89 V1=1,3 V5=J V6=4,5
616 Chrysler LeBaron Coupe, 1990-93 V1=1,3 V5=J, also V5=U in 92-93 V6=4,5
711 Dodge Aries, 1985-88 V1=1,3 V4=B V5=D V7=1,6,9
711 Dodge Aries, 1989 V1=1,3 V4=B V5=K V7=1,6,9
714 Dodge 600 2 door, 1985-86 V1=1 V5=V V6=5
911 Plymouth Reliant, 1985-88 V1=1,3 V4=B V5=P V7=1,6,9
911 Plymouth Reliant, 1989 V1=1,3 V4=B V5=K V7=1,6,9

Car group 619
Chrysler E-Class, 1985-89
Wheelbase 103.1 or 103.3
614 Chrysler E-Class/New Yorker, 1985-88 V5=T V6=5 V7=6
616 Chrysler LeBaron GTS, 1985-89 V1=1 V5=H V7=8
714 Dodge 600 4 door, 1985-88 V5=E V1=1 V7=6
716 Dodge Lancer, 1985-88 V5=X V1=1 V7=8
716 Dodge Lancer, 1989 V5=H V1=1 V7=8
907 Plymouth Caravelle, 1985-88 V5=J V1=1 V7=6

Car group 620
Daytona/Sundance, 1985-93
Wheelbase 97, sometimes written as 97.2
615 Chrysler Laser, 1985-87 V5=A V1=1 V7=4
715 Dodge Daytona, 1985-88 V1=1 V5=A V7=4
715 Dodge Daytona, 1989-91 V1=1 V5=G V7=4
715 Dodge Daytona, 1992-93 V1=1 V5=W V7=4
717 Dodge Shadow, 1987-88 V5=S V1=1,3 V7=4,8
717 Dodge Shadow, 1989-93 V5=P V1=1,3 V7=4,8
917 Plymouth Sundance, 1987-88 V5=S V1=1,3 V7=4,8
917 Plymouth Sundance, 1989-93 V5=P V1=1,3 V7=4,8

Car group 621
Dodge Dynasty, 1988-93
Wheelbase 104.3, sometimes written as 104.5
618 Chrysler New Yorker C, 1988 V1=1 V5=U V6=4,6 V7=6
618 Chrysler New Yorker C, 1989-93 V1=1 V5=C V6=4,6 V7=6
718 Dodge Dynasty, 1988 V5=U V1=1 V6=4,5 V7=6
718 Dodge Dynasty, 1989-93 V1=1 V5=C V6=4,5 V7=6

Car group 622
Plymouth Acclaim, 1989-93
Wheelbase 103.3, sometimes written as 103.5
616 Chrysler LeBaron sedan, 1990-93 V1=1,3 V5=A V7=6
719 Dodge Spirit, 1989-93 V1=1,3 V5=A V7=6
919 Plymouth Acclaim, 1989-93 V1=1,3 V5=A V7=6

Car group 623
Chrysler Fifth Avenue 109, 1990-93
Wheelbase 109.3, sometimes written as 109.5 or 109.6
620 Chrysler Fifth Avenue/Imperial, 1990-91 V5=Y V1=1 V7=6
620 Chrysler Fifth Avenue/Imperial, 1992-93 V1=1 V5=V V7=6

Car group 624
Dodge Viper, 1992-93
Wheelbase 96.2
713 Dodge Viper, 1992-93 V5=R

Car group 625
Chrysler LH cars, 1993
Wheelbase 113
641 Chrysler Concorde, 1993 V1=2 V5=L
741 Dodge Intrepid, 1993 V1=2 V5=D
1041 Eagle Vision, 1993 V1=2 V5=D

Ford Motors Car Groups

Car group 1226
Fairmont/Zephyr, 1985-86
Wheelbase 105.5, sometimes written as 105.6
1206 Ford LTD, 1985-86 V67=39,40 V1=1
1406 Mercury Marquis, 1985-86 V67=89,90 V1=1

Car group 1227
Ford Mustang 100, 1985-93
Wheelbase 100.4, sometimes written as 100.5
1203 Ford Mustang, 1985-86 V67=26-28 V1=1
1203 Ford Mustang, 1987-93 V67=40-45 V1=1
1403 Mercury Capri, 1985-86 V67=79 V1=1

Car group 1228
Crown Vic/Grand Marquis, 1985-93
Wheelbase 114.3 or 114.4
1216 Ford Crown Victoria, 1985-86 V67=42-44
1216 Ford Crown Victoria, 1987-93 V67=70-79
1416 Mercury Grand Marquis, 1985-86 V67=93-95
1416 Mercury Grand Marquis, 1987-93 V67=71-79

Car group 1230
Lincoln Town Car, 1985-93
Wheelbase 117.3 or 117.4
1301 Lincoln, 1985-86 V67=96 V1=1
1301 Lincoln Town Car, 1987-93 V67=81-84 V1=1

Car group 1231
Ford Escort 94.2, 1985-90
Wheelbase 94.2
1213 Ford Escort, 1985 V67=4-15,31-37
1213 Ford Escort, 1986 V67=31-37
1213 Ford Escort, 1987 V67=20-28
1213 Ford Escort, 1988 V67=20-28,90,91,93,95,98
1213 Ford Escort, 1989-90 V67=90,91,93,95,98
1214 Ford EXP, 1985-86 V67=1
1214 Ford EXP, 1987 V67=17,18
1214 Ford EXP, 1988-89 V67=17,18,88,89
1413 Mercury Lynx, 1985-86 V67=51-68
1413 Mercury Lynx, 1987 V67=20-28

Car group 1232
Lincoln Mark7, 1985-92
Wheelbase 108.6, sometimes written as 108.5
1302 Lincoln Mark7, 1985-86 V67=98 V1=1
1302 Lincoln Mark7, 1987-92 V67=91-93 V1=1
1305 Lincoln Continental, 1985-86 V67=97 V1=1
1305 Lincoln Continental, 1987 V67=97,98 V1=1

Car group 1233
Ford Thunderbird 104, 1985-88
Wheelbase 104, sometimes written as 104.2
1204 Ford Thunderbird, 1985-86 V67=46 V1=1
1204 Ford Thunderbird, 1987-88 V67=60-64 V1=1
1404 Mercury Cougar, 1985-86 V67=92 V1=1
1404 Mercury Cougar, 1987-88 V67=60-62 V1=1

Car group 1234
Ford Tempo, 1985-93
Wheelbase 99.9
1215 Ford Tempo, 1985-86 V67=18-23
1215 Ford Tempo, 1987-93 V67=30-39
1415 Mercury Topaz, 1985-86 V67=71-76
1415 Mercury Topaz, 1987-93 V67=30-38

Car group 1235
Ford Taurus, 1986-93
Wheelbase 106
1217 Ford Taurus, 1986 V67=29,30 V1=1
1217 Ford Taurus, 1987-93 V67=50-58 V1=1
1417 Mercury Sable, 1986 V67=87,88 V1=1
1417 Mercury Sable, 1987-93 V67=50-58 V1=1

Car group 1236
Lincoln Continental 109, 1988-93
Wheelbase 109
1305 Lincoln Continental, 1988-93 V67=97,98 V1=1

Car group 1237
Ford Thunderbird 113, 1989-93
Wheelbase 113
1204 Ford Thunderbird, 1989-93 V67=60-64 V1=1
1302 Lincoln Mark8, 1993 V67=91 V1=1
1404 Mercury Cougar, 1989-93 V67=60-62 V1=1

General Motors Car Groups

Car group 1838
Chevrolet Chevette 94.3, 1985-1987
Wheelbase 94.3
2013 Chevrolet Chevette 2 door, 1985-86 V4=T V5=B,J V67=8 V1=1
2013 Chevrolet Chevette 2 door, 1987 V4=T V5=B V6=2 V1=1
2213 Pontiac T1000 2 door, 1985-86 V4=T V5=L V67=8 V1=1
2213 Pontiac T1000 2 door, 1987 V4=T V5=L V6=2 V1=1

Car group 1839
GM full-sized sedan 116, 1985-93
Wheelbase 116, sometimes written as 115.9
1802 Buick LeSabre sedan, 1985 V45=BN,BP V1=1
1804 Buick Roadmaster sedan, 1992-93 V45=BN,BT V6=5 V1=1
2002 Chevrolet Caprice sedan, 1985-86 V4=B V67=47,68,69 V5=L,N
2002 Chevrolet Caprice sedan, 1987 V4=B V5=L,N,U V6=1
2002 Chevrolet Caprice sedan, 1987-93 V4=B V5=L,N,U V6=5
2102 Olds Delta 88 sedan, 1985-86 V45=BN,BY,BV V1=1
2202 Pontiac Parisienne, 1985-86 V4=B V67=69 V5=L,T
2202 Pontiac Parisienne, 1987-89 V4=B V6=5 V5=L,U

Car group 1840
GM full-sized wagon 116, 1985-93
Wheelbase 116, sometimes written as 115.9
1802 Buick Estate Wagon, 1985 V45=BR,BV V1=1
1802 Buick Estate Wagon, 1986-91 V4=B V5=R,V V1=1
1804 Buick Roadmaster wagon, 1992-93 V45=BB,BR V6=8
2002 Chevrolet Caprice wagon, 1985-86 V4=B V67=35 V5=L,N
2002 Chevrolet Caprice wagon, 1987-93 V4=B V5=L,N,U V6=8
2102 Olds Custom Cruiser, 1985-93 V45=BP V1=1
2202 Pontiac Safari, 1985-86 V4=B V67=35 V5=L
2202 Pontiac Safari, 1987-89 V4=B V6=8 V5=L

Car group 1842
Cadillac DeVille 121.5, 1985-93
Wheelbase 121.5, sometimes written as 121.4
1903 Cadillac Fleetwood Brougham, 1985-93 V4=D V5=W

Car group 1843
Chevrolet Chevette 97.3, 1985-87
Wheelbase 97.3
2013 Chevrolet Chevette 4 door, 1985-86 V4=T V5=B,J V67=68 V1=1
2013 Chevrolet Chevette 4 door, 1987 V4=T V5=B V6=6 V1=1
2213 Pontiac T1000 4 door, 1985-86 V4=T V5=L V67=68 V1=1
2213 Pontiac T1000 4 door, 1987 V4=T V5=L V6=6 V1=1

Car group 1844
GM Intermediates 108.1, 1985-86
Wheelbase 108.1, sometimes written as 108
1801 Buick Regal 4 door, 1985 V45=GJ,GK,GM V67 NE 27,37,47
2101 Olds Cutlass 4 door, 1985 V4=G V67=69 V5=K,M,R
2202 Pontiac Bonneville 4 door, 1985-86 V4=G V67=35,69 V5=N,R,S V1=2

Car group 1845
GM Sporty Intermediates 108.1, 1985-89
Wheelbase 108.1, sometimes written as 108
1810 Buick Regal 2 door, 1985 V45=GJ,GK,GM V67=27,37,47
1810 Buick Regal, 1986-89 V4=G V5=J,K,M
2010 Chevrolet Monte Carlo, 1985-89 V4=G V5=Z V1=1
2101 Olds Cutlass 2 door, 1985 V4=G V67=47 V5=K,M,R
2101 Olds Cutlass G, 1986-89 V4=G V5=K,M,R
2210 Pontiac Grand Prix 2 door, 1985-86 V4=G V67=37 V5=J,K,P V1=2
2210 Pontiac Grand Prix, 1987 V4=G V5=J,K,P

Car group 1846
GM Luxury Sports 114, 1985
Wheelbase 114, sometimes written as 113.9
1805 Buick Riviera, 1985 V4=E V5=Y,Z V1=1
1905 Cadillac Eldorado, 1985 V4=E V5=L
1914 Cadillac Seville, 1985 V4=K V5=S
2105 Oldsmobile Toronado, 1985 V4=E V5=Z V1=1

Car group 1847
GM Compact X cars, 1985
Wheelbase 104.9
1815 Buick Skylark, 1985 V4=X V5=B,C,D V1=1
2015 Chevrolet Citation, 1985 V4=X V5=H,X V1=1

Car group 1848
GM Compact J cars, 1985-93
Wheelbase 101.2, sometimes written as 101.3
1816 Buick Skyhawk, 1985-89 V4=J V5=E,S,T V1=1
1916 Cadillac Cimarron, 1985-88 V4=J V5=G
2016 Chevrolet Cavalier, 1985-93 V4=J V5=C,D,E,F V1=1
2116 Olds Firenza, 1985-88 V4=J V5=C,D V1=1
2216 Pontiac Sunbird, 1985-93 V4=J V5=B,C,D,U V1=1

Car group 1849
Chevrolet Camaro F 101, 1985-93
Wheelbase 101, sometimes written as 101.1
2009 Chevrolet Camaro, 1985-94 V4=F V5=P,S V1=1
2209 Pontiac Firebird, 1985-94 V4=F V5=S,V,W,X V1=1

Car group 1850
GM Mid-sized A 104.9, 1985-93
Wheelbase 104.9, sometimes written as 104.8
1817 Buick Century, 1985-93 V4=A V5=G,H,L
2017 Chevrolet Celebrity, 1985-90 V4=A V5=W
2117 Olds Ciera, 1985-93 V4=A V5=G,J,L,M,S
2217 Pontiac 6000, 1985-91 V4=A V5=E,F,G,H,J

Car group 1851
Chevrolet Corvette Y 96.2, 1985-93
Wheelbase 96.2
2004 Chevrolet Corvette, 1985-93 V4=Y V5=Y,Z V1=1

Car group 1852
GM Luxury C and Full-sized H 110.8, 1985-93
Wheelbase 110.8, sometimes written as 110.7
1802 Buick LeSabre, 1986-93 V4=H V5=H,P,R V1=1
1803 Buick Electra, 1985-93 V4=C V5=F,U,W,X V1=1
1903 Cadillac DeVille, 1985-89 V4=C V5=B,D,G,S but not H
1903 Cadillac coupe, 1990-93 V4=C V6 NE 5 V5=B,D,G,S,T
2102 Olds Delta 88, 1986-93 V4=H V5=N,Y V1=1
2103 Olds 98, 1985-93 V4=C V5=V,W,X V1=1
2202 Pontiac Bonneville, 1987-93 V4=H V5=E,X,Y,Z V1=1

Car group 1853
Pontiac Fiero P, 1985-88
Wheelbase 93.4
2205 Pontiac Fiero, 1985-88 V4=P V5=E,F,G,M V1=1

Car group 1854
Pontiac Grand Am N 103.4, 1985-93
Wheelbase 103.4
1818 Buick Somerset/Skylark, 1985-93 V4=N V5=C,D,J,K,M,V V1=1
2118 Olds Calais, 1985-91 V4=N V5=F,K,L,T V1=1
2121 Olds Achieva, 1992-93 V4=N V5=F,L V1=1
2218 Pontiac Grand Am, 1985-93 V4=N V5=E,G,V,W

Car group 1855
GM luxury sports cars E and Cadillac Seville K 108, 1986-93
Wheelbase 108
1805 Buick Riviera, 1986-93 V45=EY,EZ V1=1
1905 Cadillac Eldorado, 1986-93 V4=E V5=L
1914 Cadillac Seville, 1986-91 V4=K V5=S,Y
2105 Oldsmobile Toronado, 1986-92 V45=EV,EZ V1=1

Car group 1856
Chevrolet Corsica/Beretta L, 1987-93
Wheelbase 103.4
2019 Chevrolet Corsica/Beretta, 1987-93 V4=L V5=T,V,W,Z

Car group 1857
Cadillac Allante V, 1987-93
Wheelbase 99.4
1909 Cadillac Allante, 1987-93 V4=V V5=R,S

Car group 1858
Buick Reatta EC, 1988-91
Wheelbase 98.5
1821 Buick Reatta, 1988-91 V45=EC V1=1

Car group 1859
GM Mid-sized W 107.5, 1988-93
Wheelbase 107.5, sometimes written as 107.6
1820 Buick Regal, 1988-93 V4=W V5=B,D,F V1=2
2020 Chevrolet Lumina, 1990-93 V4=W V5=L,N,P
2120 Olds Cutlass Supreme, 1988-93 V4=W V5=H,R,S,T V1=1
2220 Pontiac Grand Prix, 1988-93 V4=W V5=H,J,K,P,T

Car group 1860
Cadillac sedan 113.8, 1990-93
Wheelbase 113.8 or 113.7
1903 Cadillac sedan, 1990-93 V4=C V6=5 V5=B,D,G,S,T

Car group 1861
Saturn coupe 99.2, 1991-93
Wheelbase 99.2
2402 Saturn SC coupe, 1991-93 V4=Z V6=1-4

Car group 1862
Saturn sedan 102.4, 1991-93
Wheelbase 102.4
2401 Saturn SL sedan, 1991-93 V4=Z V6=5,6
2403 Saturn SW wagon, 1993 V4=Z V6=8

Car group 1863
Cadillac Seville 111, 1992-93
Wheelbase 111
1914 Cadillac Seville, 1992-93 V45=KS,KY

Volkswagen Car Groups

Car group 3004
VW Front engine cars 94.5, 1985-93
Wheelbase 94.5, sometimes written as 94.4
3038 VW Scirocco, 1985-88 V78=53 V4=C V1=W
3042 VW Cabriolet, 1985-93 V78=15 V1=W

Car group 3005
VW Quantum, 1985-88
Wheelbase 100.4, sometimes written as 100
3041 VW Quantum, 1985-88 V78=32,33 V1=W

Car group 3006
VW Jetta 97.3, 1985-93
Wheelbase 97.3
3040 VW Jetta, 1985-90 V78=16,1G
3040 VW Jetta, 1991-93 V4=M,R,T,S V78=1G,1H,16
3042 VW Golf/GTI, 1985-90 V78=17
3042 VW Golf/GTI, 1991-93 V4=B,D,F,H V78=1G,1H
3045 VW Corrado, 1990-93 V78=50 V4=D,E

Car group 3007
VW Fox, 1987-93
Wheelbase 92.8
3044 VW Fox, 1987-93 V78=3,30

Car group 3008
VW Passat, 1990-93
Wheelbase 103.3
3046 VW Passat, 1990-93 V78=31 V1=W

Audi Car Groups

Car group 3204
Audi 4000, 1985-87
Wheelbase 99.4 to 99.8
3234 Audi 4000, 1985-87 V78=81,85

Car group 3205
Audi 5000 105.8, 1985-93
Wheelbase 105.8 to 106.4
3235 Audi 5000, 1985-88 V78=44
3237 Audi 100/200, 1989-90 V78=44
3237 Audi 100/200, 1991-93 V7=4

Car group 3206
Audi 80/90 100.2, 1988-92
Wheelbase 99.9 or 100.2
3236 Audi 80/90, 1988 V78=89
3236 Audi 80/90, 1989-92 V7=8

Car group 3207
Audi 90 102.8, 1993
Wheelbase 102.8 or 102.2
3236 Audi 90, 1993 V7=8 V8=C

BMW Car Groups

Car group 3406
BMW 500 103.8, 1985-88
Wheelbase 103.8 or 103.3
3435 BMW 500, 1985-88 V4=C,D

Car group 3407
BMW 300 101, 1985-93
Wheelbase 100.9 or 101.2
3434 BMW 300, 1985-92 V4=A,B
3434 BMW 325i convertible, 1993 V4=B V5=B

Car group 3408
BMW 600, 1985-89
Wheelbase 103.4 or 103.3
3436 BMW 600, 1985-89 V4=E

Car group 3409
BMW 700 110, 1985-86
Wheelbase 110
3437 BMW 700, 1985-86 V4=F

Car group 3410
BMW 700 111.5, 1987-93
Wheelbase 111.5
3437 BMW 700, 1987-92 V45=FH,GB
3437 BMW 700, 1993 V4=G V6=4

Car group 3411
BMW 700L 116, 1987-93
Wheelbase 116
3437 BMW 700L, 1987-92 V45=FC,GC
3437 BMW 700L, 1993 V4=G V6=8

Car group 3412
BMW 500 108.7, 1989-93
Wheelbase 108.7
3435 BMW 500, 1989-93 V4=H

Car group 3413
BMW 850, 1991-93
Wheelbase 105.7
3438 BMW 850, 1991-93 V4=E

Car group 3414
BMW 300 106.3, 1992-93
Wheelbase 106.3
3434 BMW 325, 1992 V4=C
3434 BMW 300 except convertible, 1993 V4=C or V45=BE,BF

Nissan Car Groups

Car group 3514
Nissan 280-300ZX 91.3, 1985-88
Wheelbase 91.3
3534 Nissan 280-300ZX, 1985-88 V5=Z V7=4 V6=1

Car group 3515
Nissan 280-300ZX 2+2 99.2, 1985-89
Wheelbase 91.3
3534 Nissan 280-300ZX, 1985-88 V5=Z V7=6 V6=1
3534 Nissan 300ZX, 1989 V5=Z V6=1 V4=C,H

Car group 3518
Nissan Sentra 94.5, 1985-86
Wheelbase 94.5 FWD
3543 Nissan Sentra, 1985-86 V5=B V6=1 V4=P,S

Car group 3519
Nissan Stanza 97.2, 1985-86
Wheelbase 97.2 FWD
3542 Nissan Stanza, 1985-86 V5=T V6=1 V4=H

Car group 3520
Nissan Pulsar 95, 1985-86
Wheelbase 95, sometimes written as 95.1 FWD
3544 Nissan Pulsar, 1985-86 V5=N V6=2 V4=M

Car group 3521
Nissan 200SX 95.5, 1985-88
Wheelbase 95.5
3532 Nissan 200SX, 1985-88 V5=S V6=2 V4=C,P,V

Car group 3522
Nissan Maxima/Stanza 100.4, 1985-93
Wheelbase 100.4 FWD
3539 Nissan Maxima, 1985-88 V5=U V6=1 V4=H V7=1,5
3542 Nissan Stanza sedan, 1987-89 V5=T V6=2 V4=H
3542 Nissan Stanza, 1990-92 V5=U V6=2 V4=F
5833 Infiniti G20, 1991-93 V5=P V4=C

Car group 3523
Nissan Stanza wagon 99, 1986-89
Wheelbase 99 FWD
3542 Nissan Stanza wagon, 1986-89 V5=M V6=0

Car group 3524
Nissan Sentra/Pulsar 95.7, 1987-93
Wheelbase 95.7 FWD
3543 Nissan Sentra, 1987-90 V5=B V6=2 V4=G,P
3543 Nissan Sentra, 1991-93 V5=B V7=1,2 V6=3
3544 Nissan Pulsar, 1987-90 V5=N V6=3 V7=4
3546 Nissan NX, 1991-93 V5=B V7=4,6 V6=3

Car group 3525
Nissan Maxima 104.3, 1989-93
Wheelbase 104.3 FWD
3539 Nissan Maxima, 1989-93 V5=J V6=0 V7=1

Car group 3526
Nissan 240SX 97.4, 1989-93
Wheelbase 97.4
3532 Nissan 240SX, 1989-93 V5=S V6=3 V4=H,M

Car group 3527
Nissan 300ZX 96.5, 1990-93
Wheelbase 96.5
3534 Nissan 300ZX, 1990-93 V5=Z V7=4,7 V6=2

Car group 3528
Nissan 300ZX 2+2 101.2, 1990-93
Wheelbase 101.2
3534 Nissan 300ZX, 1990-93 V5=Z V7=6 V6=2

Car group 3529
Infiniti M30, 1990-92
Wheelbase 103
5831 Infiniti M30, 1990-92 V5=F V4=H

Car group 3721
Acura Legend sedan 114.6, 1991-93
Wheelbase 114.6
5432 Acura Legend sedan, 1991-93 V46=KA7

Car group 3722
Honda Civic 2HB 101.3, 1992-93
Wheelbase 101.3
3731 Honda Civic 2HB, 1992-93 V46=EH2,EH3

Car group 3723
Honda Civic sedan 103.2, 1992-93
Wheelbase 103.2
3731 Honda Civic sedan, 1992-93 V46=EG8,EH9

Car group 3724
Acura Vigor, 1992-93
Wheelbase 110.5
5434 Acura Vigor, 1992-93 V46=CC2

Car group 3725
Honda Civic del Sol, 1993
Wheelbase 93.3
3735 Honda Civic del Sol, 1993 V46=EG1,EH6,EJ1,EJ2

Isuzu Car Groups

Car group 3801
Isuzu I-Mark 94.3, 1985
Wheelbase 94.3
3831 Isuzu I-Mark, 1985 V5=T V4=A,R

Car group 3802
Isuzu Impulse, 1985-89
Wheelbase 96.1
3832 Isuzu Impulse, 1985-89 V5=R V4=A,B V6=0

Car group 3803
Chevrolet Spectrum, 1985-89
Wheelbase 94.5
2031 Chevrolet Spectrum, 1985-89 V4=R V13=J81 V5=E,F,G
3831 Isuzu I-Mark, 1986-89 V5=T V4=R

Car group 3804
Geo Storm, 1990-93
Wheelbase 96.5
2035 Geo Storm, 1990-93 V4=R V13=J81 V5=F,T
3832 Isuzu Impulse, 1990-92 V4=R V6=2,4
3833 Isuzu Stylus, 1990-93 V4=R V6=5

Jaguar Car Groups

Car group 3903
Jaguar XJ sedan 113, 1985-93
Wheelbase 113, sometimes written as 112.8
3932 Jaguar XJ sedan, 1985-93 V4=A,B,F,H,K,M

Car group 3904
Jaguar XJ-S coupe, 1985-93
Wheelbase 102
3931 Jaguar XJ-S, 1985-93 V4=N,S,T

Mazda Car Groups

Car group 4107
Mazda RX-7 95.3, 1985
Wheelbase 95.3, sometimes written as 95
4134 Mazda RX-7, 1985 V45=FB

Car group 4109
Mazda GLC 93.1, 1985-86
Wheelbase 93.1 FWD
4135 Mazda GLC, 1985-86 V45=BD

Car group 4110
Mazda 626 98.8 FWD, 1985-87
Wheelbase 98.8 FWD
4137 Mazda 626, 1985-87 V45=GC

Car group 4111
Mazda 323, 1986-90
Wheelbase 94.5 or 94.7
1436 Mercury Tracer, 1988-90 V67=10-16 V13=3MA
4135 Mazda 323, 1986-89 V45=BF
4135 Mazda 323 wagon, 1987-88 V45=BW

Car group 4112
Mazda RX-7 95.7, 1986-91
Wheelbase 95.7
4134 Mazda RX-7, 1986-91 V45=FC

Car group 4113
Mazda 626 101.4, 1988-92
Wheelbase 101.4
4137 Mazda 626, 1988-92 V46=GD2

Car group 4114
Mazda 929 106.7, 1988-91
Wheelbase 106.7
4143 Mazda 929, 1988-91 V45=HC

Car group 4115
Mazda MX6/Probe 99, 1988-92
Wheelbase 99
1218 Ford Probe, 1988-92 V67=20-22 V13=1ZV V5=T
4144 Mazda MX6, 1988-92 V46=GD3

Car group 4116
Mazda 323 Hatchback 96.5, 1990-93
Wheelbase 96.5
4135 Mazda 323, 1990-93 V45=BG V67=23

Car group 4117
Ford Escort 98.4, 1990-93
Wheelbase 98.4
1213 Ford Escort, 1990-93 V67=10-16
1436 Mercury Tracer, 1991-93 V67=10-16 V13=3MA
4135 Mazda 323 Protege, 1990-93 V45=BG V67=22

Car group 4118
Mazda Miata, 1990-93
Wheelbase 89.2
4145 Mazda Miata, 1990-93 V45=NA

Car group 4119
Mazda MX3, 1992-93
Wheelbase 96.3
4146 Mazda MX3, 1992-93 V45=EC

Car group 4120
Mazda 929 112.2, 1992-93
Wheelbase 112.2
4143 Mazda 929, 1992-93 V45=HD

Car group 4121
Mazda 626/Probe 102.9, 1993
Wheelbase 102.9
1218 Ford Probe, 1993 V67=20-22 V13=1ZV V5=T
4137 Mazda 626, 1993 V46=GE2
4144 Mazda MX6, 1993 V46=GE3

Car group 4122
Mazda RX-7 95.5, 1993
Wheelbase 95.5
4134 Mazda RX-7, 1993 V45=FD

Mercedes Car Groups

Car group 4204
Mercedes SL roadster 96.9, 1985
Wheelbase 96.9
4233 Mercedes 380SL, 1985 V46=BA4

Car group 4208
Mercedes basic sedan 110, 1985
Wheelbase 110
4231 Mercedes basic sedan, 1985 V46=AA3,AB2,AB3,AB9

Car group 4209
Mercedes basic C coupe 106.7, 1985
Wheelbase 106.7
4231 Mercedes basic coupe, 1985 V46=AA5,AB5

Car group 4210
Mercedes S (super) sedan 115.6, 1985-91
Wheelbase 115.6
4237 Mercedes SD/SE, 1985-91 V47=CA24,CA32,CB20,CB34

Car group 4211
Mercedes SEL (long super) sedan 121.1, 1985-91
Wheelbase 121.1, sometimes written as 120.9
4236 Mercedes SDL/SEL, 1985-91 V47=CA25,CA33,CA35,CA37,CA39,CB25,CB35

Car group 4212
Mercedes SEC coupe 112.2, 1985-91
Wheelbase 112.2
4236 Mercedes SEC, 1985-91 V46=CA4

Car group 4213
Mercedes 190, 1985-93
Wheelbase 104.9
4239 Mercedes 190, 1985-93 V46=DA2,DB2,DA3

Car group 4214
Mercedes basic sedan 110.2, 1986-93
Wheelbase 110.2
4231 Mercedes basic sedan, 1986-93 V4=E V6=2,3,9

Car group 4215
Mercedes SL roadster 96.7, 1986-89
Wheelbase 96.7
4233 Mercedes 560SL, 1986-89 V46=BA4

Car group 4216
Mercedes basic C coupe 106.9, 1988-93
Wheelbase 106.9
4231 Mercedes basic coupe, 1988-91 V4=E V6=5
4231 Mercedes basic 2-door, 1992-93 V4=E V6=5,6

Car group 4217
Mercedes SL roadster 99, 1990-93
Wheelbase 99.0
4233 Mercedes 300SL/500SL, 1990-93 V46=FA6,FA7

Car group 4218
Mercedes SE/SD and SEC 119.7, 1992-93
Wheelbase 119.7 or 119.5
4236 Mercedes SEC coupe, 1992-93 V4=G V6=7
4237 Mercedes SE/SD, 1992-93 V4=G V6=3,4

Car group 4219
Mercedes SEL 123.6, 1992-93
Wheelbase 123.6
4236 Mercedes SEL, 1992-93 V4=G V6=5

Peugeot Car Groups

Car group 4406
Peugeot 505 sedan, 1985-91
Wheelbase 107.9 or 108
4434 Peugeot 505 sedan, 1985-89 V45=BA
4434 Peugeot 505 sedan, 1990-91 V4=B,C V6=1

Car group 4407
Peugeot 505 wagon, 1985-91
Wheelbase 114.2
4434 Peugeot 505 wagon, 1985-89 V45=BD; also BF in 88-89
4434 Peugeot 505 wagon, 1990-91 V4=B,C V6 NE 1

Car group 4408
Peugeot 405, 1989-91
Wheelbase 105.1
4436 Peugeot 405, 1989-91 V4=D,E

Porsche Car Groups

Car group 4501
Porsche 911, 1985-91
Wheelbase 89.5, sometimes written as 89.4; rear engine
4531 Porsche 911, 1985-90 V78=91,93
4531 Porsche 911, 1991 V78=96

Car group 4503
Porsche 924/944, 1985-91
Wheelbase 94.5
4534 Porsche 924, 1985-88 V78=92 V4 NE J
4537 Porsche 944, 1985-91 V78=94,95

Car group 4504
Porsche 928, 1985-91
Wheelbase 99.3 or 98.4
4535 Porsche 928, 1985-91 V78=92 V4=J

Car group 4208
Mercedes basic sedan 110, 1985
Wheelbase 110
4231 Mercedes basic sedan, 1985 V46=AA3,AB2,AB3,AB9

Car group 4209
Mercedes basic C coupe 106.7, 1985
Wheelbase 106.7
4231 Mercedes basic coupe, 1985 V46=AA5,AB5

Car group 4210
Mercedes S (super) sedan 115.6, 1985-91
Wheelbase 115.6
4237 Mercedes SD/SE, 1985-91 V47=CA24,CA32,CB20,CB34

Car group 4211
Mercedes SEL (long super) sedan 121.1, 1985-91
Wheelbase 121.1, sometimes written as 120.9
4236 Mercedes SDL/SEL, 1985-91 V47=CA25,CA33,CA35,CA37,CA39,CB25,CB35

Car group 4212
Mercedes SEC coupe 112.2, 1985-91
Wheelbase 112.2
4236 Mercedes SEC, 1985-91 V46=CA4

Car group 4213
Mercedes 190, 1985-93
Wheelbase 104.9
4239 Mercedes 190, 1985-93 V46=DA2,DB2,DA3

Car group 4214
Mercedes basic sedan 110.2, 1986-93
Wheelbase 110.2
4231 Mercedes basic sedan, 1986-93 V4=E V6=2,3,9

Car group 4215
Mercedes SL roadster 96.7, 1986-89
Wheelbase 96.7
4233 Mercedes 560SL, 1986-89 V46=BA4

Car group 4216
Mercedes basic C coupe 106.9, 1988-93
Wheelbase 106.9
4231 Mercedes basic coupe, 1988-91 V4=E V6=5
4231 Mercedes basic 2-door, 1992-93 V4=E V6=5,6

Car group 4217
Mercedes SL roadster 99, 1990-93
Wheelbase 99.0
4233 Mercedes 300SL/500SL, 1990-93 V46=FA6,FA7

Car group 4218
Mercedes SE/SD and SEC 119.7, 1992-93
Wheelbase 119.7 or 119.5
4236 Mercedes SEC coupe, 1992-93 V4=G V6=7
4237 Mercedes SE/SD, 1992-93 V4=G V6=3,4

Car group 4219
Mercedes SEL 123.6, 1992-93
Wheelbase 123.6
4236 Mercedes SEL, 1992-93 V4=G V6=5

Peugeot Car Groups

Car group 4406
Peugeot 505 sedan, 1985-91
Wheelbase 107.9 or 108
4434 Peugeot 505 sedan, 1985-89 V45=BA
4434 Peugeot 505 sedan, 1990-91 V4=B,C V6=1

Car group 4407
Peugeot 505 wagon, 1985-91
Wheelbase 114.2
4434 Peugeot 505 wagon, 1985-89 V45=BD; also BF in 88-89
4434 Peugeot 505 wagon, 1990-91 V4=B,C V6 NE 1

Car group 4408
Peugeot 405, 1989-91
Wheelbase 105.1
4436 Peugeot 405, 1989-91 V4=D,E

Porsche Car Groups

Car group 4501
Porsche 911, 1985-91
Wheelbase 89.5, sometimes written as 89.4; rear engine
4531 Porsche 911, 1985-90 V78=91,93
4531 Porsche 911, 1991 V78=96

Car group 4503
Porsche 924/944, 1985-91
Wheelbase 94.5
4534 Porsche 924, 1985-88 V78=92 V4 NE J
4537 Porsche 944, 1985-91 V78=94,95

Car group 4504
Porsche 928, 1985-91
Wheelbase 99.3 or 98.4
4535 Porsche 928, 1985-91 V78=92 V4=J

Car group 4505
Porsche, 1992-93
4540 Porsche, 1992-93 specific model not decodable from VIN characters 1-8

Renault Car Groups

Car group 4605
Renault 18/Fuego, 1985-86
Wheelbase 96.1
4637 Renault R18i/Sportwagon, 1985-86 V67=34,35
4638 Renault Fuego, 1985 V67=36

Car group 4606
Renault Alliance, 1985-87
Wheelbase 97.8 or 97.2
4639 Renault Alliance, 1985-87 V67=95,96,97; also 93,99 in 87
4640 Renault Encore, 1985-86 V67=93,99

Car group 4607
Renault Medallion sedan, 1988-89
Wheelbase 102.3
4644 Renault Medallion sedan, 1988-89 V67=45

Car group 4608
Renault Medallion wagon, 1988-89
Wheelbase 108.3
4644 Renault Medallion wagon, 1988-89 V67=48

Car group 4609
Eagle Premier, 1988-92
Wheelbase 106
740 Dodge Monaco, 1990-92 V5=B V1=2
1040 Eagle Premier, 1988-89 V67=55 V13=1AC,2XM
1040 Eagle Premier, 1988-92 V5=B V1=2

Saab Car Groups

Car group 4704
Saab 900 99.4, 1985-93
Wheelbase 99.1 or 99.4
4731 Saab 900, 1985-93 V4=A V6=2,3,4,7

Car group 4705
Saab 9000, 1985-93
Wheelbase 105.1 or 105.2
4734 Saab 9000, 1985-93 V4=C V6=4,5,6

Subaru Car Groups

Car group 4806
Subaru sedan 97, 1985-93
Wheelbase 96.9-97.2, track width 56
4831 Subaru sedan, 1985-91 V4=A V5=C,G,K,N
4831 Subaru Loyale, 1992-93 V4=A V6=4,5
4835 Subaru XT, 1985-91 V4=A V5=X

Car group 4807
Subaru hatchback 93, 1985-89
Wheelbase 93.3-93.7, track width 56
4831 Subaru hatchback, 1985-89 V4=A V5=F

Car group 4808
Subaru Justy, 1987-93
Wheelbase 90
4836 Subaru Justy, 1987-93 V4=K V5=A,D

Car group 4809
Subaru Legacy, 1990-93
Wheelbase 101.6
4834 Subaru Legacy, 1990-93 V4=B V6=6

Car group 4810
Subaru SVX, 1992-93
Wheelbase 102.8
4837 Subaru SVX, 1992-93 V4=C V13=JF1 V5=X

Car group 4811
Subaru Impreza, 1993
Wheelbase 99.2
4838 Subaru Impreza, 1993 V4=G V5=C,F

Toyota Car Groups

Car group 4911
Toyota Celica 98.4, 1985-86
Wheelbase 98.3, track width 54
4933 Toyota Celica, 1985 V5=A V7 NE 7 V6=6 V4=R
4933 Toyota Celica, 1986 V5=T V6=6 V4=S

Car group 4912
Toyota Cressida 104.1, 1985
Wheelbase 104.1
4935 Toyota Cressida, 1985 V5=X V6=7 V4=M

Car group 4916
Toyota Corolla 94.5, 1985-87
Wheelbase 94.5
4932 Toyota Corolla 2 door, 1985-87 V5=E V8=C,S V6=8 V4=A

Car group 4918
Toyota Supra 103, 1985-86
Wheelbase 103
4934 Toyota Supra, 1985-86 V5=A V7=7 V6=6 V4=M

Car group 4919
Toyota Tercel/Corolla 95.7, 1985-92
Wheelbase 95.7 FWD
2032 Chevrolet Nova, 1985-89 V4=S V13=1Y1 V5=K,L
2032 Geo Prizm, 1990-92 V4=S V13=1Y1 V5=K,L
4932 Toyota Corolla 4 door, 1985-87 V5=E V8=E,L V6=8 V4=A
4932 Toyota Corolla FX-16, 1987-88 V5=E V8=G V6=8 V4=A
4932 Toyota Corolla, 1988-92 V5=E V6=9 V4=A
4938 Toyota Tercel, 1985-86 V5=L V6=3 V4=A
4938 Toyota Tercel wagon, 1987 V5=L V8=V,W V6=3 V4=A

Car group 4920
Toyota Camry 102.4, 1985-91
Wheelbase 102.4
4940 Toyota Camry, 1985-86 V5=V V6=1 V4=C,S
4940 Toyota Camry, 1987-91 V5=V V6=2 V4=S,V
5931 Lexus ES-250, 1990-91 V5=V V4=V

Car group 4921
Toyota MR-2 91.3, 1985-89
Wheelbase 91.3
4941 Toyota MR-2, 1985-89 V5=W V6=1 V4=A

Car group 4922
Toyota Cressida 104.5, 1986-92
Wheelbase 104.5-105.5
4935 Toyota Cressida, 1986-92 V5=X V4=M V7=2,3

Car group 4923
Toyota Supra 102.2, 1986-92
Wheelbase 102.2
4934 Toyota Supra, 1986-92 V5=A V6=7 V7=0,1 V4=M

Car group 4924
Toyota Celica 99.4, 1987-93
Wheelbase 99.4
4933 Toyota Celica, 1987-89 V5=T V6=6 V4=S
4933 Toyota Celica, 1990-93 V5=T V6=8 V4=A,S

Car group 4925
Toyota Tercel 93.7, 1987-93
Wheelbase 93.7 FWD
4938 Toyota Tercel liftback, 1987 V5=L V8=D,G,H V6=3 V4=E
4938 Toyota Tercel, 1988-91 V5=L V6=3,4 V4=A,E
4938 Toyota Tercel, 1992 V5=L V8=A,B V6=4
4938 Toyota Tercel, 1993 V5=L V8=S,T V6=4
4942 Toyota Paseo, 1992 V5=L V8=F V6=4
4942 Toyota Paseo, 1993 V5=L V8=U V6=4

Car group 4926
Lexus LS-400, 1990-93
Wheelbase 110.8
5932 Lexus LS-400, 1990-93 V5=F V4=U

Car group 4927
Toyota MR-2 94.5, 1991-93
Wheelbase 94.5
4941 Toyota MR-2, 1991-93 V5=W V6=2 V4=S

Car group 4928
Toyota Camry 103.1, 1992-93
Wheelbase 103.1
4940 Toyota Camry, 1992-93 V5=K V6=1 V4=S,V
5931 Lexus ES-300, 1992-93 V5=K V4=V

Car group 4929
Lexus SC-300/400, 1992-93
Wheelbase 105.9
5933 Lexus SC-300/400, 1992-93 V5=Z V6=3 V4=J,U

Car group 4930
Toyota Corolla 97, 1993
Wheelbase 97
2032 Geo Prizm, 1993 V2=Y V4=S
4932 Toyota Corolla, 1993 V5=E V6=0

Car group 4931
Toyota Supra 100.4, 1993
Wheelbase 100.4
4934 Toyota Supra, 1993 V5=A V6=8

Car group 4932
Lexus GS-300, 1993
Wheelbase 109.4
5934 Lexus GS-300, 1993 V5=S V6=4

Volvo Car Groups

Car group 5104
Volvo 240, 1985-93
Wheelbase 104.3, sometimes written as 104
5134 Volvo 240, 1985-93 V4=A V6=4,8

Car group 5105
Volvo 700/900, 1985-93
Wheelbase 109.1
5138 Volvo 760/780, 1985-91 V4=D,G,H V6=6,7,8
5139 Volvo 740, 1985-92 V4=F V6=7,8
5140 Volvo 940, 1991-93 V4=J
5141 Volvo 960, 1991-93 V4=K

Car group 5106
Volvo 850, 1993
Wheelbase 104.9
5142 Volvo 850, 1993 V4=L

Mitsubishi Car Groups

Car group 5204
Colt/Champ 90.6, 1985
Wheelbase 90.6
734 Dodge Colt 2 door, 1985 V1=J V5=A,E V7=4
934 Plymouth Colt 2 door, 1985 V1=J V5=A,E V7=4

Car group 5205
Hyundai Excel 93.7, 1985-90
Wheelbase 93.7
734 Dodge Colt 4 door, 1985 V1=J V5=A,E V7=6,8
734 Dodge Colt, 1986-88 V1=J V5=A V7=4,6,8
734 Dodge Colt 4WD, 1986-88 V14=JB4E V5=A
734 Dodge Colt DL wagon, 1989-90 V1=J V5=U V7=8
734 Dodge Colt DL 4WD wagon, 1989-90 V14=JB4E V5=V,W
934 Plymouth Colt 4 door, 1985 V1=J V5=A,E V7=6,8
934 Plymouth Colt, 1986-88 V1=J V5=A V7=4,6,8
934 Plymouth Colt 4WD, 1986-88 V14=JP4E V5=A
934 Plymouth Colt DL wagon, 1989-90 V1=J V5=U V7=8
934 Plymouth Colt DL 4WD wagon, 1989-90 V14=JP4E V5=V,W
5235 Mitsubishi Mirage, 1985-88 V1=J V5=A V7=4,6
5236 Mitsubishi Precis, 1987-89 V1=K V2=M,P V4=L
5532 Hyundai Excel, 1986-89 V4=L V5=A,D,F

Car group 5206
Mitsubishi Starion, 1985-89
Wheelbase 95.9
635 Chrysler Conquest, 1987-89 V1=J V5=C V7=4
735 Dodge Conquest, 1985-86 V1=J V5=C V7=4
935 Plymouth Conquest, 1985-86 V1=J V5=C V7=4
5231 Mitsubishi Starion, 1985-88 V1=J V5=C V7=4

Car group 5207
Mitsubishi Tredia/Cordia, 1985-88
Wheelbase 96.3
5232 Mitsubishi Tredia, 1985-87 V1=J V5=F V7=6
5233 Mitsubishi Cordia, 1985-88 V1=J V5=F V7=4

Car group 5208
Colt Vista, 1985-91
Wheelbase 103.3-103.5
744 Dodge Colt Vista, 1985-91 V1=J V5=G V7=9 V6=3,4
744 Dodge Colt Vista 4WD, 1985-91 V15=JB4FH
944 Plymouth Colt Vista, 1985-91 V1=J V5=G V7=9 V6=3,4
944 Plymouth Colt Vista 4WD, 1985-91 V15=JP4FH

Car group 5209
Mitsubishi Galant 102.4, 1985-93
Wheelbase 102.4
5234 Mitsubishi Galant, 1985-88 V5=B V7=6,7 V1=J
5234 Mitsubishi Galant, 1989-92 V1=J V5=R,X V7=6
5234 Mitsubishi Galant, 1993 V5=H
5238 Mitsubishi Sigma, 1989-91 V1=J V5=B V7=7

Car group 5210
Mitsubishi Mirage 96.7, 1989-92
Wheelbase 96.7
1034 Eagle Summit, 1989-91 V5=U V7=4,6
1034 Eagle Summit sedan, 1992 V5=U V7=6
5235 Mitsubishi Mirage, 1989 V1=J V5=U V7=4,6
5235 Mitsubishi Mirage sedan, 1990-92 V5=U V7=6

Car group 5211
Dodge Colt 93.9, 1989-92
Wheelbase 93.9
734 Dodge Colt 2HB, 1989-92 V1=J V5=U V7=4
934 Plymouth Colt 2HB, 1989-92 V1=J V5=U V7=4
1034 Eagle Summit 2HB, 1992 V5=U V7=4
5235 Mitsubishi Mirage 2HB, 1990-92 V1=J V5=U V7=4

Car group 5212
Mitsubishi Eclipse 97.2, 1990-93
Wheelbase 97.2
937 Plymouth Laser, 1990-92 V1=1,4 V5=S,T V7=4
937 Plymouth Laser, 1993 V1=1,4 V5=F,G V7=4
1037 Eagle Talon, 1990-92 V1=1,4 V5=S,T V7=4
1037 Eagle Talon, 1993 V1=1,4 V5=F,G V7=4
5237 Mitsubishi Eclipse, 1990-92 V5=S,T V7=4
5237 Mitsubishi Eclipse, 1993 V5=F,G V7=4

Car group 5213
Dodge Stealth, 1991-93
Wheelbase 97.2, track width 62
739 Dodge Stealth, 1991-92 V5=D,E V1=J V7=4
739 Dodge Stealth, 1993 V5=M,N V1=J V7=4
5239 Mitsubishi 3000GT, 1991-92 V1=J V5=D,E V7=4
5239 Mitsubishi 3000GT, 1993 V1=J V5=M,N V7=4

Car group 5214
Mitsubishi LRV, 1992-93
Wheelbase 99.2
744 Dodge Colt Vista, 1992 V1=J V5=V,W
744 Dodge Colt Vista, 1993 V1=J V5=B,C
944 Plymouth Colt Vista, 1992 V1=J V5=V,W
944 Plymouth Colt Vista, 1993 V1=J V5=B,C
1044 Eagle Summit wagon, 1992 V5=V,W
1044 Eagle Summit wagon, 1993 V1=J V5=B,C
5244 Mitsubishi Expo LRV, 1992 V1=J V5=V,W
5244 Mitsubishi Expo LRV, 1993 V1=J V5=B,C

Car group 5215
Mitsubishi Diamante, 1992-93
Wheelbase 107.1
5240 Mitsubishi Diamante, 1992 V5=C V1=J
5240 Mitsubishi Diamante, 1993 V5=P or (V5=C and V13=6MM)
5245 Mitsubishi Expo SP, 1992 V5=Y,Z
5245 Mitsubishi Expo SP, 1993 V5=D,E

Car group 5216
Dodge Colt 2 door 96.1, 1993
Wheelbase 96.1
734 Dodge Colt 2 door, 1993 V1=J V5=A V7=1-5
934 Plymouth Colt 2 door, 1993 V1=J V5=A V7=1-5
1034 Eagle Summit 2 door, 1993 V1=J V5=A V7=1-5
5235 Mitsubishi Mirage 2 door, 1993 V1=J V5=A V7=1-5

Car group 5217
Dodge Colt 4 door 98.4, 1993
Wheelbase 98.4
734 Dodge Colt 4 door, 1993 V1=J V5=A V7=6-8
934 Plymouth Colt 4 door, 1993 V1=J V5=A V7=6-8
1034 Eagle Summit 4 door, 1993 V1=J V5=A V7=6-8
5235 Mitsubishi Mirage 4 door, 1993 V1=J V5=A V7=6-8

Suzuki Car Groups

Car group 5301
Chevrolet Sprint 88.4, 1985-88
Wheelbase 88.4
2033 Chevrolet Sprint, 1985-86 V4=M V13=JG1 V5=R,S
2033 Chevrolet Sprint 2 door, 1987-88 V4=M V6=1,2 V13=JG1 V5=R,S

Car group 5302
Chevrolet Sprint 92.3, 1987-88
Wheelbase 92.3
2033 Chevrolet Sprint 4 door, 1987-88 V4=M V6=6 V13=JG1 V5=R,S

Car group 5303
Geo Metro 89.2, 1989-93
Wheelbase 89.2
2034 Geo Metro 2 door, 1989-93 V4=M V6=1,2,3 V13=JG1,2C1 V5=R,S,T
5334 Suzuki Swift 2 door, 1989-93 V5=A,C

Car group 5304
Geo Metro 93.1, 1989-93
Wheelbase 93.1
2034 Geo Metro 4 door, 1989-93 V4=M V6=6 V13=JG1,2C1 V5=R,S,T
5334 Suzuki Swift 4 door, 1989-93 V5=B,D,E,H

Hyundai Car Groups

Car group 5501
Hyundai Sonata, 1989-93
Wheelbase 104.3
5533 Hyundai Sonata, 1989-93 V4=B V5=F

Car group 5502
Hyundai Excel 93.8, 1990-93
Wheelbase 93.8
5236 Mitsubishi Precis, 1990-93 V1=K V2=P V4=V
5532 Hyundai Excel, 1990-93 V4=V V5=D,F
5534 Hyundai Scoupe, 1991-93 V4=V V5=E

Car group 5503
Hyundai Elantra, 1992-93
Wheelbase 98.4
5535 Hyundai Elantra, 1992-93 V4=J V5=F

Taunus Car Groups

Car group 5603
Merkur XR4Ti, 1985-89
Wheelbase 102.7
5631 Merkur XR4Ti, 1985-89 V67=80

Car group 5604
Merkur Scorpio, 1988-90
Wheelbase 108.7
5632 Merkur Scorpio, 1988-90 V67=81

Yugo Car Groups

Car group 5701
Yugo, 1986-91
Wheelbase 84.7
5731 Yugo, 1986-91 V4=B

Daihatsu Car Groups

Car group 6001
Daihatsu Charade, 1988-92
Wheelbase 92.1
6031 Daihatsu Charade, 1988-92 V5=G

Daewoo Car Groups

Car group 6301
Pontiac LeMans, 1988-93
Wheelbase 99.2
2231 Pontiac LeMans, 1988-93 V4=T V13=KL2 V5=N,R,S,X

Kia Car Groups

Car group 6401
Ford Festiva, 1988-93
Wheelbase 90.2
1234 Ford Festiva, 1988 V67=6,7,10,12,13 V13=KNJ V5=T
1234 Ford Festiva, 1989-93 V67=5-7 V13=KNJ V5=T

Australian Ford Car Groups

Car group 6501
Mercury Capri XR-2, 1989-93
Wheelbase 94.7 FWD
1431 Mercury Capri, 1989-93 V13=6MP V67=1,3 V5=T

APPENDIX C

FUNDAMENTAL LIGHT TRUCK GROUPS, 1985-93
(Shared Body Platforms)

1. The first line of the definition assigns a four-digit number to the light truck group; the first two digits indicate the manufacturer, (70=AMC, 71=Chrysler, 74=Ford, 76=GM, etc.); the last two digits are sequential and generally chronological for that manufacturer.

2. The second line assigns a name to the light truck group and gives the limits of the range of model years for the various make-models in the group. Light truck groups are often named after the largest selling make-model with that body platform and/or the wheelbase of that platform (to the nearest inch).

3. The third line specifies the type of trucks included in the group: compact or full-sized pickup, compact or full-sized SUV, compact or full-sized van, or car-based pickup.

4. The fourth line shows the range of wheelbases of the trucks in that group, as derived from "Light Truck Specifications" in Ward's Almanac or Automotive News.

5. The remaining lines list the specific make-models included in the light truck group, including a four-digit make-model code, the make-model name (plus additional specifications such as "extended cab" if not every truck of that make-model is in that group during the specified time period), a range of model years, and the VIN characters that identify specifically which trucks belong to this group (V3 is the 3rd character of the VIN, V34 is the 3rd and 4th character, etc.).

American Motors (Jeep) Light Truck Groups

Light truck group 7001
Jeep "J" Pickup 118.7, 1985-86
Full-sized pickup truck
Wheelbase 118.7 (short bed)
7001 Jeep J-10 4x4 short-bed pickup, 1985-86 V67=25

Light truck group 7002
Jeep "J" Pickup 130.7, 1985-88
Full-sized pickup truck
Wheelbase 130.7 (long bed)
7002 Jeep J-10 4x4 long-bed pickup, 1985-88 V67=26
7003 Jeep J-20 4x4 long-bed pickup, 1985-88 V67=27

Light truck group 7003
Jeep CJ-8 Scrambler, 1985-86
Compact open-body SUV
Wheelbase 103.4
7004 Jeep CJ-8 Scrambler 4x4, 1985-86 V3=C V67=88

Light truck group 7004
Jeep CJ-7, 1985-86
Compact open-body SUV
Wheelbase 93.4
7005 Jeep CJ-7 4x4, 1985-86 V3=C V67=87,89

Light truck group 7005
Jeep Cherokee, 1985-93
Compact SUV
Wheelbase 101.4 (sometimes written as 101.0)
7006 Jeep Cherokee, 1985-88 V3=C V67=73,74
7006 Jeep Cherokee, 1989-93 V1=1 V3=4 V4=F V5=T V7=7,8
7007 Jeep Cherokee 4x4, 1985-88 V3=C V67=77,78,79
7007 Jeep Cherokee 4x4, 1989-93 V1=1 V3=4 V4=F V5=J V7=7,8

Light truck group 7006
Jeep Wagoneer, 1985-92
Compact SUV
Wheelbase 101.4 (sometimes written as 101.0)
7008 Jeep Wagoneer 4x4, 1985-88 V3=C V67=75
7008 Jeep Wagoneer/Cherokee Briarwood 4x4, 1989-92 V1=1 V3=4 V4=F V5=N V7=8

Light truck group 7007
Jeep Grand Wagoneer, 1985-92
Full-sized SUV
Wheelbase 108.7 (sometimes written as 109.0)
7009 Jeep Grand Wagoneer 4x4, 1985-88 V3=C V67=15
7009 Jeep Grand Wagoneer 4x4, 1989-92 V1=1 V3=4 V4=G V5=S V7=8

Light truck group 7008
Jeep Comanche 119.9, 1986-88
Compact pickup truck
Wheelbase 119.9
7010 Jeep Comanche long bed, 1986-88 V3=T V67=66
7011 Jeep Comanche 4x4 long bed, 1986-88 V3=T V67=65

Light truck group 7009
Jeep Comanche 113, 1987-88
Compact pickup truck
Wheelbase 113
7012 Jeep Comanche, 1987-88 V3=T V67=64
7013 Jeep Comanche 4x4, 1987-88 V3=T V67=63

Light truck group 7010
Jeep Wrangler, 1987-93
Compact open-body SUV
Wheelbase 93.4 (sometimes written as 93.5)
7014 Jeep Wrangler 4x4, 1987-88 V1=2 V3=C V67=81
7014 Jeep Wrangler 4x4, 1989-92 V1=2 V3=4 V4=F V5=Y V7=9
7014 Jeep Wrangler 4x4, 1993 V1=1 V3=4 V4=F V5=Y V7=9

Light truck group 7011
Jeep Comanche 113/119.9, 1989-92
Compact pickup truck
Wheelbase 113 (short bed) or 119.9 (long bed)
7015 Jeep Comanche, 1989-92 V1=1 V3=7 V4=F V5=T V7=6
7016 Jeep Comanche 4x4, 1989-92 V1=1 V3=7 V4=F V5=J V7=6

Chrysler Corp. Domestic Light Truck Groups

Light truck group 7101
Caravan/Voyager 112.0, 1985-90
Compact van
Wheelbase 112.0
7101 Dodge Caravan, 1985-88 V1=2 (or 1 in 87) V3=4 V4=F V5=K V7=1
7101 Dodge Caravan, 1989-90 V1=2 (or 1 in 87) V3=4 V4=F V5=K V7=5
7102 Dodge Mini Ram Van, 1985-88 V1=2 (or 1/87) V3=6(?),7 V4=E,F,G V5=K V7=3
7102 Dodge Mini Ram Van, 1989-90 V1=2 (or 1/87) V3=6(?),7 V4=E,F,G V5=K V7=1
7201 Plymouth Voyager, 1985-88 V1=2 (or 1 in 87) V3=4 V4=F V5=H V7=1
7201 Plymouth Voyager, 1989-90 V1=2 (or 1 in 87) V3=4 V4=F V5=H V7=5

Light truck group 7102
Dodge D/W 150 Pickup, 1985-93
Full-sized pickup truck
Wheelbase 115 (short bed) or 131 (long bed)
7103 Dodge D100 pickup, 1985-88 V1=1 V3=7 V4=F-G V56=D0 V7=4
7103 Dodge D100/D150S pickup, 1989-91 V1=1,3 V3=7 V4=F-G V56=E0 V7=6
7104 Dodge D150 pickup, 1985-88 V1=1 V3=7 V4=F-H V56=D1 V7=4
7104 Dodge D150 pickup, 1989-93 V1=1,3 V3=7 V4=F-H V56=E1 V7=6
7105 Dodge W100 4wd pickup, 1985-88 V1=1 V3=7 V4=H V56=W0 V7=4
7105 Dodge W100/W150S 4wd pickup, 1989-91 V1=1,3 V3=7 V4=H V56=M0 V7=6
7106 Dodge W150 4wd pickup, 1985-88 V1=1 V3=7 V4=H V56=W1 V7=4
7106 Dodge W150 4wd pickup, 1989-93 V1=1,3 V3=7 V4=H V56=M1 V7=6

Light truck group 7103
Dodge D/W 250/350 Pickup, 1985-93
Full-sized pickup truck
Wheelbase 131
7107 Dodge D250 pickup, 1985-88 V3=7 V4=H,J,K V56=D2 V7=4
7107 Dodge D250 pickup, 1989-93 V3=7 V4=H,J,K V56=E2 V7=6
7108 Dodge W250 4wd pickup, 1985-88 V3=7 V4=H,J,K V56=W2 V7=4
7108 Dodge W250 4wd pickup, 1989-93 V3=7 V4=H,J,K V56=M2 V7=6
7109 Dodge D350 pickup, 1985-88 V3=7 V56=D3 V7=4
7109 Dodge D350 pickup, 1989-93 V3=7 V4=K,L V56=E3 V7=6
7110 Dodge W350 4wd pickup, 1985-88 V3=7 V56=W3 V7=4
7110 Dodge W350 4wd pickup, 1989-93 V3=7 V4=K,L V56=M3 V7=6

Light truck group 7104
Dodge D/W Crew Cab Pickup 149/165, 1985-88
Full-sized pickup truck
Wheelbase 149 (short bed) or 165 (long bed)
7111 Dodge D350 crew cab pickup, 1985-88 V1=1 V3=7 V4=K V56=D3 V7=5,6
7112 Dodge W350 crew cab pickup, 1985-88 V1=1 V3=7 V56=W3 V7=5,6

Light truck group 7105
Dodge Ramcharger, 1985-93
Full-sized SUV
Wheelbase 106
7113 Dodge Ramcharger, 1985-88 V1=1,3 V3=4 V4=G V56=D0,D1 V7=2
7113 Dodge Ramcharger, 1989-93 V1=3 V3=4 V4=G,H V5=E V7=7
7114 Dodge Ramcharger 4x4, 1985-88 V1=1,3 V3=4 V4=G,H V56=W0,W1 V7=2
7114 Dodge Ramcharger 4x4, 1989-93 V1=3 V3=4 V4=G,H V5=M V7=7

Light truck group 7106
Dodge Ram Van 109.6/127.6, 1985-93
Full-sized van
Wheelbase 109.6 or 127.6
7115 Dodge B150 Ram Van, 1985-88 V1=2 V3=6(?),7 V4=F,G V56=B1 V7=3
7115 Dodge B150 Ram Van, 1989-93 V1=2 V3=6(?),7 V4=F,G V56=B1 V7=1
7116 Dodge B150 Ram Wagon, 1985-88 V1=2 V3=4 V4=F-H V56=B1 V7=1
7116 Dodge B150 Ram Wagon, 1989-93 V1=2 V3=4 V4=F-H V56=B1 V7=5
7117 Dodge B250 Ram Van, 1985-88 V1=2 V3=6(?),7 V4=H V56=B2 V7=3
7117 Dodge B250 Ram Van, 1989-93 V1=2 V3=6(?),7 V4=H V56=B2 V7=1

Light truck group 7107
Dodge Ram Van 127.6, 1985-93
Full-sized van
Wheelbase 127.6
7118 Dodge B250 Ram Wagon, 1985-88 V1=2 V3=4 V4=H V56=B2 V7=1
7118 Dodge B250 Ram Wagon, 1989-93 V1=2 V3=4 V4=H V56=B2 V7=5
7119 Dodge B350 Ram Van, 1985-88 V1=2 V3=6(?),7 V4=J,K V56=B3 V7=3
7119 Dodge B350 Ram Van, 1989-93 V1=2 V3=6(?),7 V4=J,K V56=B3 V7=1
7120 Dodge B350 Ram Wagon, 1985-88 V1=2 V34=4H,4K,5W(?) V56=B3 V7=1
7120 Dodge B350 Ram Wagon, 1989-93 V1=2 V34=4H,4K,5W(?) V56=B3 V7=5

Light truck group 7108
Dodge Dakota 111.9/123.9, 1987-93
Compact pickup truck
Wheelbase 111.9 (short bed) or 123.9 (long bed)
7130 Dodge Dakota, 1987-88 V1=1 V3=7 V4=E-G V56=N1,N6 V7=4
7130 Dodge Dakota, 1989-93 V1=1 V3=7 V4=F-H V5=L V7=6
7131 Dodge Dakota 4x4, 1987-88 V1=1 V3=7 V4=F-G V56=R1,R6 V7=4
7131 Dodge Dakota 4x4, 1989-93 V1=1 V3=7 V4=F-H V5=G V7=6

Light truck group 7109
Grand Caravan/Grand Voyager, 1988-90
Compact van
Wheelbase 119.1
7132 Dodge Grand Caravan, 1988 V1=1 V3=4 V4=F-G V5=K V7=0
7132 Dodge Grand Caravan, 1989-90 V1=1 V3=4 V4=F-G V5=K V7=4
7133 Dodge Mini Ram Van (extended), 1988 V1=1 V3=6(?),7 V4=E-G V5=K V7=3
7133 Dodge Mini Ram Van (extended), 1989-90 V1=1 V3=6(?),7 V4=E-G V5=K V7=4
7202 Plymouth Grand Voyager, 1988 V1=1 V3=4 V4=F-G V5=H V7=0
7202 Plymouth Grand Voyager, 1989-90 V1=1 V3=4 V4=F-G V5=H V7=4
7301 Chrysler Town & Country, 1990 V1=1 V3=4 V4=G V5=Y V7=4

Light truck group 7110
Dodge D/W Club Cab Pickup 149, 1990-93
Full-sized pickup truck
Wheelbase 149.0
7134 Dodge D150 club cab pickup, 1990-93 V1=1,3 V3=7 V4=F-H V56=E1 V7=3
7135 Dodge W150 4x4 club cab pickup, 1990-93 V1=1,3 V3=7 V4=F-H V56=M1 V7=3
7136 Dodge D250 club cab pickup, 1990-93 V1=1,3 V3=7 V4=H,J,K V56=E2 V7=3
7137 Dodge W250 4x4 club cab, 1990-93 V1=1,3 V3=7 V4=H,J,K V56=M2 V7=3

Light truck group 7111
Dodge Dakota Club Cab 131, 1990-93
Compact pickup truck
Wheelbase 131.0
7138 Dodge Dakota Club Cab, 1990-93 V1=1 V3=7 V4=F-G V5=L V7=3
7139 Dodge Dakota Club Cab 4x4, 1990-93 V1=1 V3=7 V4=F-G V5=G V7=3

Light truck group 7112
Caravan/Voyager 112.3, 1991-93
Compact van
Wheelbase 112.3
7140 Dodge Caravan, 1991 V1=2 V3=4 V4=F-G V5=K V7=5
7140 Dodge Caravan, 1992-93 V1=2 V3=4 V4=F-G V5=H V7=5
7141 Dodge Caravan 4x4, 1991 V1=2 V3=4 V4=G V5=D V7=5
7141 Dodge Caravan 4x4, 1992-93 V1=2 V3=4 V4=G V5=K V7=5
7142 Dodge Caravan cargo, 1991 V1=2 V3=7 V4=F-G V5=K V7=1
7142 Dodge Caravan cargo, 1992-93 V1=2 V3=7 V4=F-G V5=H V7=1
7143 Dodge Caravan cargo 4x4, 1991 V1=2 V3=7 V4=G V5=D V7=1
7143 Dodge Caravan cargo 4x4, 1992-93 V1=2 V3=7 V4=G V5=K V7=1
7203 Plymouth Voyager, 1991-93 V1=2 V3=4 V4=F-G V5=H V7=5
7204 Plymouth Voyager 4x4, 1991 V1=2 V3=4 V4=G V5=P V7=5
7204 Plymouth Voyager 4x4, 1992-93 V1=2 V3=4 V4=G V5=K V7=5

Light truck group 7113
Grand Caravan/Voyager 119.3, 1991-93
Compact van
Wheelbase 119.3
7144 Dodge Grand Caravan, 1991 V1=1 V3=4 V4=G V5=K V7=4
7144 Dodge Grand Caravan, 1992-93 V1=1 V3=4 V4=G V5=H V7=4
7145 Dodge Grand Caravan 4x4, 1991 V1=1 V3=4 V4=G V5=D V7=4
7145 Dodge Grand Caravan 4x4, 1992-93 V1=1 V3=4 V4=G V5=K V7=4
7146 Dodge Caravan cargo extended, 1991 V1=1 V3=7 V4=G V5=K V7=4
7146 Dodge Caravan cargo extended, 1992-93 V1=1 V3=7 V4=G V5=H V7=4
7147 Dodge Caravan cargo 4x4 extended, 1991 V1=1 V3=7 V4=G V5=D V7=4
7147 Dodge Caravan cargo 4x4 extended, 1992-93 V1=1 V3=7 V4=G V5=K V7=4
7205 Plymouth Grand Voyager, 1991-93 V1=1 V3=4 V4=G V5=H V7=4
7206 Plymouth Grand Voyager 4x4, 1991 V1=1 V3=4 V4=G V5=P V7=4
7206 Plymouth Grand Voyager 4x4, 1992-93 V1=1 V3=4 V4=G V5=K V7=4
7302 Chrysler Town & Country, 1991 V1=1 V3=4 V4=G V5=Y V7=4
7302 Chrysler Town & Country, 1992-93 V1=1 V3=4 V4=G V5=H V7=4
7303 Chrysler Town & Country 4x4, 1992-93 V1=1 V3=4 V4=G V5=K V7=4

Light truck group 7114
Jeep Grand Cherokee, 1993
Compact SUV
Wheelbase 105.9
7017 Jeep Grand Cherokee, 1993 V1=1 V3=4 V4=G V5=W V6=5-7 V7=8
7018 Jeep Grand Cherokee 4x4, 1993 V1=1 V3=4 V4=G V5=Z V6=5-7 V7=8
7019 Jeep Grand Wagoneer 4x4, 1993 V1=1 V3=4 V4=G V5=Z V6=8 V7=8

Ford Motors Light Truck Groups

Light truck group 7401
Ford Ranger 107.9/113.9, 1985-92
Compact pickup truck
Wheelbase 107.9 (short bed) or 113.9 (long bed)
7401 Ford Ranger, 1985-92 V1=1 V3=T V4=B-C V57=R10
7402 Ford Ranger 4x4, 1985-92 V1=1 V3=T V4=B-C V57=R11

Light truck group 7402
Ford F150 Pickup, 1985-93
Full-sized pickup truck
Wheelbase 116.8 (short bed) or 133.0 (long bed)
7403 Ford F150 pickup, 1985-93 V3=T V4=C-E V57=F15
7404 Ford F150 4x4 pickup, 1985-93 V3=T V4=D-F V57=F14

Light truck group 7403
Ford F250/350 Pickup, 1985-93
Full-sized pickup truck
Wheelbase 133.0
7405 Ford F250 pickup, 1985-93 V3=T V4=E-H V57=F25
7406 Ford F250 4x4 pickup, 1985-93 V3=T V4=E-H V57=F26
7407 Ford F350 pickup, 1985-93 V3=T V4=H-J V57=F35
7408 Ford F350 4x4 pickup, 1985-93 V3=T V4=H-J V57=F36

Light truck group 7404
Ford F150 Supercab Pickup, 1985-93
Full-sized pickup truck
Wheelbase 138.8 (short bed) or 155.0 (long bed)
7409 Ford F150 supercab pickup, 1985-93 V1=1 V3=T V4=D-F V57=X15
7410 Ford F150 4x4 supercab pickup, 1985-93 V1=1 V3=T V4=D-F V57=X14

Light truck group 7405
Ford F250/350 Supercab Pickup 155.0, 1985-93
Full-sized pickup truck
Wheelbase 155.0
7411 Ford F250 supercab pickup, 1985-93 V3=T V4=H V57=X25
7412 Ford F250 4x4 supercab pickup, 1985-93 V3=T V4=H V57=X26
7413 Ford F350 supercab pickup, 1985-88 V3=T V4=H-J V57=W35
7414 Ford F350 4x4 supercab pickup, 1985-88 V3=T V4=H-J V57=W36
7431 Ford F350 supercab dual-rear-wheel, 1988-93 V3=T V4=J V57=X35

Light truck group 7406
Ford Bronco II, 1985-90
Compact SUV
Wheelbase 94.0
7415 Ford Bronco II 4x4, 1985-90 V1=1 V3=M V4=B-C V57=U14
7416 Ford Bronco II, 1986-90 V1=1 V3=M V4=B-C V57=U12

Light truck group 7407
Ford Bronco, 1985-93
Full-sized SUV
Wheelbase 104.7 (sometimes written as 105.0)
7417 Ford Bronco 4x4, 1985-93 V1=1 V3=M V4=D-E V57=U15

Light truck group 7408
Ford van 124/138, 1985-90
Full-sized van
Wheelbase 124.0 or 138.0
7418 Ford E-150 (cargo), 1985-90 V1=1 V3=D(?),T V4=D-E V56=E1 V7=4-6

Light truck group 7409
Ford van 138, 1985-91
Full-sized van
Wheelbase 138.0
7418 Ford E-150 (cargo), 1991 V1=1 V3=D(?),T V4=D-E V56=E1 V7=4-6
7419 Ford E-150 Super Van, 1985-91 V1=1 V3=D(?),T V4=D,E V56=S1 V7=4-6
7420 Ford E-150 Club Wagon, 1985-91 V1=1 V3=M V4=E V56=E1 V7=1
7421 Ford E-250 (cargo), 1985-91 V1=1 V3=D(?),T V4=E-H V56=E2 V7=4-6
7422 Ford E-250 Super Van, 1985-91 V1=1 V3=D(?),T V4=F-H V56=S2 V7=4-6
7423 Ford E-250 Club Wagon, 1985-91 V1=1 V3=B(?),M V4=E-H V56=E2 V7=1
7424 Ford E-350 (cargo), 1985-91 V1=1 V3=D(?),T V4=H,J V56=E3 V7=4-6
7425 Ford E-350 Super Van, 1985-91 V1=1 V3=D(?),T V4=H,J V56=S3 V7=4-6
7426 Ford E-350 Super Club Wagon, 1985-91 V1=1 V3=B(?),M V4=H,J V56=S3 V7=1

Light truck group 7410
Ford Ranger Supercab, 1986-92
Compact pickup truck
Wheelbase 125.0
7427 Ford Ranger Supercab, 1986-92 V1=1 V3=T V4=C V57=R14
7428 Ford Ranger Supercab 4x4, 1986-92 V1=1 V3=T V4=C V57=R15

Light truck group 7411
Ford Aerostar, 1986-93
Compact van
Wheelbase 118.9
7429 Ford Aerostar Van (cargo), 1986-93 V1=1 V3=D(?),T V4=C-D V57=A14,A15
7430 Ford Aerostar Wagon, 1986-93 V1=1 V3=M V4=C-D V57=A11
7432 Ford Aerostar extended van, 1989-93 V1=1 V3=D(?),T V4=C-D V57=A34,A35
7433 Ford Aerostar extended Wagon, 1989-93 V1=1 V3=M V4=C-D V57=A31
7436 Ford Aerostar 4x4 Van (cargo), 1990-93 V1=1 V3=D(?),T V4=D V57=A24,A25
7437 Ford Aerostar 4x4 Wagon, 1990-93 V1=1 V3=M V4=C-D V57=A21
7438 Ford Aerostar 4x4 extended van, 1990-93 V1=1 V3=D(?),T V4=D V57=A44,A45
7439 Ford Aerostar 4x4 extended Wagon, 1990-93 V1=1 V3=M V4=D V57=A41

Light truck group 7412
Ford F350 Crew Cab Pickup 168.4, 1989-93
Full-sized pickup truck
Wheelbase 168.4
7434 Ford F350 Crew Cab pickup, 1989-93 V1=2 V3=T V4=J V57=W35
7435 Ford F350 4x4 Crew Cab pickup, 1989-93 V1=2 V3=T V4=J V57=W36

Light truck group 7413
Ford Explorer 2dr 102.1, 1991-93
Compact SUV
Wheelbase 102.1
7440 Ford Explorer 2dr, 1991-93 V1=1 V3=M V4=C V57=U22
7441 Ford Explorer 2dr 4x4, 1991-93 V1=1 V3=M V4=C-D V57=U24
8310 Mazda Navajo 4x4, 1991-93 V13=4F2 V45=CU V6=4 V7=4
8311 Mazda Navajo, 1992-93 V13=4F2 V45=CU V6=4 V7=2

Light truck group 7414
Ford Explorer 4dr 111.9, 1991-93
Compact SUV
Wheelbase 111.9
7442 Ford Explorer 4dr, 1991-93 V1=1 V3=M V4=D V57=U32
7443 Ford Explorer 4dr 4x4, 1991-93 V1=1 V3=M V4=D V57=U34

Light truck group 7415
Ford van 138 (92 redesign), 1992-93
Full-sized van
Wheelbase 138.0
7444 Ford E-150 (cargo), 1992-93 V1=1 V3=D(?),T V4=D-E V57=E14
7445 Ford E-150 Club Wagon, 1992-93 V1=1 V3=M V4=E V57=E11
7446 Ford E-250 (cargo), 1992-93 V1=1 V3=D(?),T V4=E-H V57=E24
7447 Ford E-250 Super Van, 1992-93 V1=1 V3=D(?),T V4=F-H V57=S24
7448 Ford E-350 (cargo), 1992-93 V1=1 V3=D(?),T V4=H,J V57=E34
7449 Ford E-350 Super Van, 1992-93 V1=1 V3=D(?),T V4=H,J V57=S34
7450 Ford E-350 Club Wagon, 1992-93 V1=1 V3=B(?),M V4=H,J V57=E31
7451 Ford E-350 Super Club Wagon, 1992-93 V1=1 V3=B(?),M V4=H,J V57=S31

Light truck group 7416
Ford Ranger 108.0/114.0, 1993
Compact pickup truck
Wheelbase 108.0 (short bed) or 114.0 (long bed)
7452 Ford Ranger, 1993 V1=1 V3=T V4=C V57=R10
7453 Ford Ranger 4x4, 1993 V1=1 V3=T V4=C V57=R11

Light truck group 7417
Ford Ranger Supercab (1993 redesign), 1993
Compact pickup truck
Wheelbase 125.0
7454 Ford Ranger Supercab, 1993 V1=1 V3=T V4=C-D V57=R14
7455 Ford Ranger Supercab 4x4, 1993 V1=1 V3=T V4=C-D V57=R15

Light truck group 7418
Mercury Villager, 1993
Compact van
Wheelbase 112.2
7501 Mercury Villager Van (cargo), 1993 V13=4M2 V4=D V57=V14
7502 Mercury Villager Wagon, 1993 V13=4M2 V4=D V57=V11

General Motors Light Truck Groups

Light truck group 7601
GM S/T pickup 108.3/117.9/122.9, 1985-87
Compact pickup truck
Wheelbase 108.3 (short bed) or 117.9 (long bed) or 122.9 (maxicab)
7601 Chevrolet S10 pickup, 1985-87 V1=1 V3=C V4=B-C V57=S14
7602 Chevrolet T10 4x4 pickup, 1985-87 V1=1 V3=C V4=B-D V57=T14
7701 GMC S15 pickup, 1985-87 V1=1 V3=T V4=B-C V57=S14
7702 GMC T15 4x4 pickup, 1985-87 V1=1 V3=T V4=B-D V57=T14

Light truck group 7602
GM C/K/R/V 10 pickup, 1985-88
Full-sized pickup truck
Wheelbase 117.5 (short bed) or 131.5 (long bed) or 155.5 (extended cab)
7603 Chevrolet C10/R10 pickup, 1985-86 V3=C V4=C-E V57=C14
7603 Chevrolet C10/R10 pickup, 1987-88 V3=C V4=C-E V57=R14
7604 Chevrolet K10/V10 4x4 pickup, 1985-86 V3=C V4=D-E V57=K14
7604 Chevrolet K10/V10 4x4 pickup, 1987-88 V3=C V4=D-E V57=V14
7703 GMC C15/R15 pickup, 1985-86 V3=T V4=C-E V57=C14
7703 GMC C15/R15 pickup, 1987-88 V3=T V4=C-E V57=R14
7704 GMC K15/V15 4x4 pickup, 1985-86 V3=T V4=D-E V57=K14
7704 GMC K15/V15 4x4 pickup, 1987-88 V3=T V4=D-E V57=V14

Light truck group 7603
GM C/K/R/V 20/30 pickup 131.5/155.5, 1985-89
Full-sized pickup truck
Wheelbase 131.5 (regular cab) or 155.5 (extended cab)
7605 Chevrolet C20/R20 pickup, 1985-86 V3=B(?),C V4=E-G V57=C24
7605 Chevrolet C20/R20 pickup, 1987 V3=B(?),C V4=E-G V57=R24
7606 Chevrolet K20/V20 4x4 pickup, 1985-86 V3=B(?),C V4=E-G V57=K24
7606 Chevrolet K20/V20 4x4 pickup, 1987 V3=B(?),C V4=E-G V57=V24
7607 Chevrolet C30/R30 pickup, 1985-86 V3=B(?),C V4=G-H V57=C34
7607 Chevrolet C30/R30 pickup, 1987-89 V3=B(?),C V4=G-H V57=R34
7608 Chevrolet K30/V30 4x4 pickup, 1985-86 V3=B(?),C V4=H V57=K34
7608 Chevrolet K30/V30 4x4 pickup, 1987-89 V3=B(?),C V4=H V57=V34
7705 GMC C25/R25 pickup, 1985-86 V3=D(?),T V4=E-G V57=C24
7705 GMC C25/R25 pickup, 1987 V3=D(?),T V4=E-G V57=R24
7706 GMC K25/V25 4x4 pickup, 1985-86 V3=D(?),T V4=E-G V57=K24
7706 GMC K25/V25 4x4 pickup, 1987 V3=D(?),T V4=E-G V57=V24
7707 GMC C35/R35 pickup, 1985-86 V3=D(?),T V4=G-H V57=C34
7707 GMC C35/R35 pickup, 1987-89 V3=D(?),T V4=G-H V57=R34
7708 GMC K35/V35 4x4 pickup, 1985-86 V3=D(?),T V4=H V57=K34
7708 GMC K35/V35 4x4 pickup, 1987-89 V3=D(?),T V4=H V57=V34

Light truck group 7604
GM S Blazer/Jimmy 2dr 100.5, 1985-93
Compact SUV
Wheelbase 100.5
7609 Chevrolet S10 Blazer 2dr, 1985-86 V1=1 V3=8 V4=C V57=S18
7609 Chevrolet S10 Blazer 2dr, 1987-93 V1=1 V3=N V4=C V57=S18
7610 Chevrolet S10 4x4 Blazer 2dr, 1985-86 V1=1 V3=8 V4=C V57=T18
7610 Chevrolet S10 4x4 Blazer 2dr, 1987-93 V1=1 V3=N V4=C V57=T18
7709 GMC S15 Jimmy 2dr, 1985-86 V1=1 V3=5 V4=C V57=S18
7709 GMC S15 Jimmy 2dr, 1987-93 V1=1 V3=K V4=C V57=S18
7710 GMC S15 4x4 Jimmy 2dr, 1985-86 V1=1 V3=5 V4=C V57=T18
7710 GMC S15 4x4 Jimmy 2dr, 1987-93 V1=1 V3=K V4=C V57=T18

Light truck group 7605
GM K/V Blazer/Jimmy 106.5, 1985-91
Full-sized SUV
Wheelbase 106.5
7611 Chevrolet K10/V10 4x4 Blazer, 1985-86 V1=1 V3=8 V4=E V57=K18
7611 Chevrolet K10/V10 4x4 Blazer, 1987-91 V1=1 V3=N V4=E V57=V18
7711 GMC K15/V15 4x4 Jimmy, 1985-86 V1=1 V3=5 V4=E V57=K18
7711 GMC K15/V15 4x4 Jimmy, 1987-91 V1=1 V3=K V4=E V57=V18

Light truck group 7606
GM C/K/R/V 10 Suburban 129.5, 1985-91
Full-sized SUV
Wheelbase 129.5
7612 Chevrolet C10/R10 Suburban, 1985-86 V1=1 V3=8 V4=E-F V57=C16
7612 Chevrolet C10/R10 Suburban, 1987-91 V1=1 V3=N V4=E-F V57=R16
7613 Chevrolet K10/V10 4x4 Suburban, 1985-86 V1=1 V3=8 V4=E-F V57=K16
7613 Chevrolet K10/V10 4x4 Suburban, 1987-91 V1=1 V3=N V4=E-F V57=V16
7712 GMC C15/R15 Suburban, 1985-86 V1=1 V3=5 V4=E-F V57=C16
7712 GMC C15/R15 Suburban, 1987-91 V1=1 V3=K V4=E-F V57=R16
7713 GMC K15/V15 4x4 Suburban, 1985-86 V1=1 V3=5 V4=E-F V57=K16
7713 GMC K15/V15 4x4 Suburban, 1987-91 V1=1 V3=K V4=E-F V57=V16

Light truck group 7607
GM C/K/R/V 20 Suburban 129.5, 1985-91
Full-sized SUV
Wheelbase 129.5
7614 Chevrolet C20/R20 Suburban, 1985-86 V1=1 V3=8 V4=G V57=C26
7614 Chevrolet C20/R20 Suburban, 1987-91 V1=1 V3=N V4=G V57=R26
7615 Chevrolet K20/V20 4x4 Suburban, 1985-86 V1=1 V3=8 V4=G V57=K26
7615 Chevrolet K20/V20 4x4 Suburban, 1987-91 V1=1 V3=N V4=G V57=V26
7714 GMC C25/R25 Suburban, 1985-86 V1=1 V3=5 V4=G V57=C26
7714 GMC C25/R25 Suburban, 1987-91 V1=1 V3=K V4=G V57=R26
7715 GMC K25/V25 4x4 Suburban, 1985-86 V1=1 V3=5 V4=G V57=K26
7715 GMC K25/V25 4x4 Suburban, 1987-91 V1=1 V3=K V4=G V57=V26

Light truck group 7608
GM Astro/Safari van, 1985-93
Compact van
Wheelbase 111.0
7616 Chevrolet Astro cargo van, 1985-93 V1=1 V3=B(?),C V4=C,D V57=M15
7617 Chevrolet Astro passenger van, 1985-86 V1=1 V3=8 V4=C,D V57=M15
7617 Chevrolet Astro passenger van, 1987-93 V1=1 V3=N V4=C,D V57=M15
7644 Chevrolet Astro extended cargo van, 1990-93 V1=1 V3=B(?),C V4=D V57=M19
7645 Chevrolet Astro extended psgr van, 1990-93 V1=1 V3=N V4=D V57=M19
7646 Chevrolet Astro 4x4 cargo van, 1990-93 V1=1 V3=B(?),C V4=D V57=L15
7647 Chevrolet Astro 4x4 passenger van, 1990-93 V1=1 V3=N V4=D V57=L15
7648 Chevrolet Astro 4x4 ext cargo van, 1990-93 V1=1 V3=B(?),C V4=D,E V57=L19
7649 Chevrolet Astro 4x4 extended psgr van, 1990-93 V1=1 V3=N V4=D,E V57=L19
7716 GMC Safari cargo van, 1985-93 V1=1 V3=D(?),T V4=C,D V57=M15
7717 GMC Safari passenger van, 1985-86 V1=1 V3=5 V4=C,D V57=M15
7717 GMC Safari passenger van, 1987-93 V1=1 V3=K V4=C,D V57=M15
7744 GMC Safari extended cargo van, 1990-93 V1=1 V3=D(?),T V4=D V57=M19
7745 GMC Safari extended passenger van, 1990-93 V1=1 V3=K V4=D V57=M19
7746 GMC Safari 4x4 cargo van, 1990-93 V1=1 V3=D(?),T V4=D V57=L15
7747 GMC Safari 4x4 passenger van, 1990-93 V1=1 V3=K V4=D V57=L15
7748 GMC Safari 4x4 ext cargo van, 1990-93 V1=1 V3=D(?),T V4=D,E V57=L19
7749 GMC Safari 4x4 extended psgr van, 1990-93 V1=1 V3=K V4=D,E V57=L19

Light truck group 7609
GM van 110/125, 1985-93
Full-sized van
Wheelbase 110.0 or 125.0
7618 Chevrolet G10 Chevy Van (cargo), 1985-93 V3=B(?),C V4=C-D V57=G15
7619 Chevrolet G10 Sportvan (passenger), 1985-86 V3=8 V57=G15
7619 Chevrolet G10 Sportvan (passenger), 1987-93 V3=N V57=G15
7620 Chevrolet G20 Chevy Van (cargo), 1985-93 V3=B(?),C V4=E V57=G25
7718 GMC 1500 Vandura (cargo), 1985-93 V3=D(?),T V4=C-D V57=G15
7719 GMC 1500 Rally (passenger), 1985-86 V3=5 V57=G15
7719 GMC 1500 Rally (passenger), 1987-93 V3=K V57=G15
7720 GMC 2500 Vandura (cargo), 1985-93 V3=D(?),T V4=E V57=G25

Light truck group 7610
GM van 125, 1985-93
Full-sized van
Wheelbase 125.0
7621 Chevrolet G20 Sportvan (passenger), 1985-86 V3=8 V4=E V57=G25
7621 Chevrolet G20 Sportvan (passenger), 1987-93 V3=N V4=E V57=G25
7622 Chevrolet G30 Chevy Van (cargo), 1985-93 V3=B(?),C V4=F-H V57=G35
7623 Chevrolet G30 Sportvan, 1985-86 V3=A(?),8 V4=F-H V57=G35
7623 Chevrolet G30 Sportvan, 1987-93 V3=A(?),N V4=F-H V57=G35
7721 GMC 2500 Rally (passenger), 1985-86 V3=5 V4=E V57=G25
7721 GMC 2500 Rally (passenger), 1987-93 V3=K V4=E V57=G25
7722 GMC 3500 Vandura (cargo), 1985-93 V3=D(?),T V4=F-H V57=G35
7723 GMC 3500 Rally (passenger), 1985-86 V3=0(?),J(?),5 V4=F-H V57=G35
7723 GMC 3500 Rally (passenger), 1987-93 V3=0(?),J(?),K V4=F-H V57=G35

Light truck group 7611
GM El Camino/Caballero, 1985-87
Pickup car
Wheelbase 117.1
7624 Chevrolet El Camino, 1985-87 V1=3 V3=C V5=W
7724 GMC Caballero, 1985-87 V1=3 V3=T V5=W

Light truck group 7612
GM C/K/R/V 20/30 4 dr pickup 164.5, 1985-91
Full-sized pickup truck
Wheelbase 164.5
7625 Chevrolet C20/R20 4 dr pickup, 1985-86 V3=B(?),C V4=G V57=C23
7625 Chevrolet C20/R20 4 dr pickup, 1987-89 V3=B(?),C V4=G V57=R23
7626 Chevrolet K20/V20 4x4 4 dr pickup, 1985-86 V3=B(?),C V4=G V57=K23
7626 Chevrolet K20/V20 4x4 4 dr pickup, 1987-89 V3=B(?),C V4=G V57=V23
7627 Chevrolet C30/R30 4 dr pickup, 1985-86 V3=B(?),C V4=G,H V57=C33
7627 Chevrolet C30/R30 4 dr pickup, 1987-91 V3=B(?),C V4=G,H V57=R33
7628 Chevrolet K30/V30 4 dr pickup, 1985-86 V3=B(?),C V4=H V57=K33
7628 Chevrolet K30/V30 4 dr pickup, 1987-91 V3=B(?),C V4=H V57=V33
7725 GMC C25/R25 4 dr pickup, 1985-86 V3=D(?),T V4=G V57=C23
7725 GMC C25/R25 4 dr pickup, 1987-89 V3=D(?),T V4=G V57=R23
7726 GMC K25/V25 4x4 4 dr pickup, 1985-86 V3=D(?),T V4=G V57=K23
7726 GMC K25/V25 4x4 4 dr pickup, 1987-89 V3=D(?),T V4=G V57=V23
7727 GMC C35/R35 4 dr pickup, 1985-86 V3=D(?),T V4=G,H V57=C33
7727 GMC C35/R35 4 dr pickup, 1987-91 V3=D(?),T V4=G,H V57=R33
7728 GMC K35/V35 4x4 4 dr pickup, 1985-86 V3=D(?),T V4=H V57=K33
7728 GMC K35/V35 4x4 4 dr pickup, 1987-91 V3=D(?),T V4=H V57=V33

Light truck group 7613
GM S/T pickup 108.3/117.9, 1988-93
Compact pickup truck
Wheelbase 108.3 (short bed) or 117.9 (long bed)
7601 Chevrolet S10 pickup, 1988-93 V1=1 V3=C V4=B-D V57=S14
7602 Chevrolet T10 4x4 pickup, 1988-93 V1=1 V3=C V4=B-D V57=T14
7701 GMC S15/Sonoma pickup, 1988-93 V1=1 V3=T V4=B-D V57=S14
7702 GMC T15/Sonoma 4x4 pickup, 1988-93 V1=1 V3=T V4=B-D V57=T14

Light truck group 7614
GM S/T Maxicab pickup, 1988-93
Compact pickup truck
Wheelbase 122.9
7629 Chevrolet S10 Maxicab pickup, 1988-93 V1=1 V3=C V4=B-D V57=S19
7630 Chevrolet T10 4x4 Maxicab pickup, 1988-93 V1=1 V3=C V4=B-D V57=T19
7729 GMC S15/Sonoma Maxicab pickup, 1988-93 V1=1 V3=T V4=B-D V57=S19
7730 GMC T15/Sonoma 4x4 Maxicab pickup, 1988-93 V1=1 V3=T V4=B-D V57=T19

Light truck group 7615
GM C/K 1500 pickup 117.5/131.5, 1988-93
Full-sized pickup truck
Wheelbase 117.5 (short bed) or 131.5 (long bed)
7631 Chevrolet C10 pickup, 1988-93 V3=C V4=D-E V57=C14
7632 Chevrolet K10 4x4 pickup, 1988-93 V3=C V4=D-E V57=K14
7731 GMC Sierra C1500 pickup, 1988-93 V3=T V4=D-E V57=C14
7732 GMC Sierra K1500 4x4 pickup, 1988-93 V3=T V4=D-E V57=K14

Light truck group 7616
GM C/K 2500/3500 pickup 131.5, 1988-93
Full-sized pickup truck
Wheelbase 131.5
7633 Chevrolet C20 pickup, 1988-93 V3=B(?),C V4=F-G V57=C24
7634 Chevrolet K20 4x4 pickup, 1988-93 V3=B(?),C V4=F-G V57=K24
7635 Chevrolet C30 pickup, 1988-93 V3=B(?),C V4=G-H V57=C34
7636 Chevrolet K30 4x4 pickup, 1988-93 V3=B(?),C V4=G-H V57=K34
7733 GMC Sierra C2500 pickup, 1988-93 V3=D(?),T V4=F-G V57=C24
7734 GMC Sierra K2500 4x4 pickup, 1988-93 V3=D(?),T V4=F-G V57=K24
7735 GMC Sierra C3500 pickup, 1988-93 V3=D(?),T V4=G-H V57=C34
7736 GMC Sierra K3500 4x4 pickup, 1988-93 V3=D(?),T V4=G-H V57=K34

Light truck group 7617
GM C/K extended-cab pickup 155.5, 1988-93
Full-sized pickup truck
Wheelbase 155.5
7637 Chevrolet C10 x-cab pickup, 1988-90 V3=C V4=D-F V57=C19
7638 Chevrolet K10 4x4 x-cab pickup, 1988-90 V3=C V4=E-F V57=K19
7639 Chevrolet C20 x-cab pickup, 1988-90 V3=B(?),C V4=F-G V57=C29
7640 Chevrolet K20 4x4 x-cab pickup, 1988-90 V3=B(?),C V4=F-G V57=K29
7641 Chevrolet C30 x-cab pickup, 1988-93 V3=B(?),C V4=G-H V57=C39
7642 Chevrolet K30 4x4 x-cab pickup, 1988-93 V3=B(?),C V4=G-H V57=K39
7737 GMC Sierra C1500 x-cab pickup, 1988-90 V3=T V4=D-F V57=C19
7738 GMC Sierra K1500 4x4 x-cab pickup, 1988-90 V3=T V4=E-F V57=K19
7739 GMC Sierra C2500 x-cab pickup, 1988-90 V3=D(?),T V4=F-G V57=C29
7740 GMC Sierra K2500 4x4 x-cab, 1988-90 V3=D(?),T V4=F-G V57=K29
7741 GMC Sierra C3500 x-cab pickup, 1988-93 V3=D(?),T V4=G-H V57=C39
7742 GMC Sierra K3500 4x4 x-cab, 1988-93 V3=D(?),T V4=G-H V57=K39
On all models, V1=2 in 88-92, V1=1,2 in 93

Light truck group 7618
GM extended van 146, 1990-93
Full-sized van
Wheelbase 146.0
7650 Chevrolet G30 Chevy Van extended, 1990-93 V3=B(?),C V4=G-H V57=G39
7651 Chevrolet G30 Sportvan extended, 1990-93 V3=A(?),N V4=G-H V57=G39
7750 GMC 3500 Vandura extended, 1990-93 V3=D(?),T V4=G-H V57=G39
7751 GMC 3500 Rally extended, 1990-93 V3=0(?),J(?),K V4=G-H V57=G39

Light truck group 7619
GM Lumina APV, 1990-93
Compact van
Wheelbase 109.8
7652 Chevrolet Lumina APV, 1990-93 V1=1 V3=N V4=C-D V57=U06
7667 Chevrolet APV Cargo Van, 1992-93 V1=1 V3=B(?),C V4=D V57=U05
7801 Oldsmobile Silhouette, 1990-93 V1=1 V3=H V4=C-D V57=U06
7901 Pontiac Trans Sport, 1990-93 V1=1 V3=M V4=C-D V57=U06

Light truck group 7620
GM C/K extended-cab pickup 141.5/155.5, 1991-93
Full-sized pickup truck
Wheelbase 141.5 (short bed) or 155.5 (long bed)
7653 Chevrolet C10 x-cab pickup, 1991-93 V3=C V4=D-F V57=C19
7654 Chevrolet K10 4x4 x-cab pickup, 1991-93 V3=C V4=E-F V57=K19
7655 Chevrolet C20 x-cab pickup, 1991-93 V3=B(?),C V4=F-G V57=C29
7656 Chevrolet K20 4x4 x-cab pickup, 1991-93 V3=B(?),C V4=F-G V57=K29
7753 GMC Sierra C1500 x-cab pickup, 1991-93 V3=T V4=D-F V57=C19
7754 GMC Sierra K1500 4x4 x-cab pickup, 1991-93 V3=T V4=E-F V57=K19
7755 GMC Sierra C2500 x-cab pickup, 1991-93 V3=D(?),T V4=F-G V57=C29
7756 GMC Sierra K2500 4x4 x-cab, 1991-93 V3=D(?),T V4=F-G V57=K29
On all models, V1=2 in 91-92, V1=1,2 in 93

Light truck group 7621
GM S Blazer/Jimmy 4dr 107.0, 1991-93
Compact SUV
Wheelbase 107.0
7657 Chevrolet S10 Blazer 4dr, 1991-93 V1=1 V3=N V4=C V57=S13
7658 Chevrolet S10 4x4 Blazer 4dr, 1991-93 V1=1 V3=N V4=D V57=T13
7757 GMC S15 Jimmy 4dr, 1991-93 V1=1 V3=K V4=C V57=S13
7758 GMC S15 4x4 Jimmy 4dr, 1991-93 V1=1 V3=K V4=D V57=T13
7802 Oldsmobile Bravada 4x4, 1991-93 V1=1 V3=H V4=D V57=T13

Light truck group 7622
GM C/K3500 Crew Cab pickup 168.5, 1992-93
Full-sized pickup truck
Wheelbase 168.5
7660 Chevrolet C30 Crew Cab pickup, 1992-93 V3=B(?),C V4=G-H V57=C33
7661 Chevrolet K30 4x4 Crew Cab pickup, 1992-93 V3=B(?),C V4=G-H V57=K33
7760 GMC Sierra C3500 Crew Cab pickup, 1992-93 V3=D(?),T V4=G-H V57=C33
7761 GMC Sierra K3500 4x4 Crew Cab, 1992-93 V3=D(?),T V4=G-H V57=K33

Light truck group 7623
GM K Blazer/Yukon 111.5, 1992-93
Full-sized SUV
Wheelbase 111.5
7662 Chevrolet K1500 4x4 Blazer, 1992-93 V1=1 V3=N V4=E-F V57=K18
7762 GMC 4x4 Yukon, 1992-93 V1=1 V3=K V4=E-F V57=K18

Light truck group 7624
GM C/K 1500 Suburban 131.5, 1992-93
Full-sized SUV
Wheelbase 131.5
7663 Chevrolet C1500 Suburban, 1992-93 V1=1 V3=N V4=E-F V57=C16
7664 Chevrolet K1500 4x4 Suburban, 1992-93 V1=1 V3=N V4=F V57=K16
7763 GMC C1500 Suburban, 1992-93 V1=1 V3=K V4=E-F V57=C16
7764 GMC K1500 4x4 Suburban, 1992-93 V1=1 V3=K V4=F V57=K16

Light truck group 7625
GM C/K 2500 Suburban 131.5, 1992-93
Full-sized SUV
Wheelbase 131.5
7665 Chevrolet C2500 Suburban, 1992-93 V1=1 V3=N V4=G V57=C26
7666 Chevrolet K2500 4x4 Suburban, 1992-93 V1=1 V3=N V4=G V57=K26
7765 GMC C2500 Suburban, 1992-93 V1=1 V3=K V4=G V57=C26
7766 GMC K2500 4x4 Suburban, 1992-93 V1=1 V3=K V4=G V57=K26

Volkswagen Light Truck Groups

Light truck group 8001
VW Vanagon, 1985-91
Compact van
Wheelbase 96.9
8001 VW Vanagon, 1985-91 V4=Y V78=25
8002 VW Camper, 1985-91 V4=Z V78=25

Nissan Light Truck Groups

Light truck group 8101
Nissan pickup 101.4, 1985-86
Compact pickup truck
Wheelbase 101.4
8101 Nissan standard-bed pickup, 1985-86 V57=D01 V8=S
8102 Nissan standard-bed 4x4 pickup, 1985-86 V57=D01 V8=Y

Light truck group 8102
Nissan pickup 110.8, 1985-86
Compact pickup truck
Wheelbase 110.8
8103 Nissan long-bed pickup, 1985-86 V57=D02 V8=S
8104 Nissan King Cab pickup, 1985-86 V57=D06 V8=S
8105 Nissan long-bed 4x4 pickup, 1985-86 V57=D02 V8=Y
8106 Nissan King Cab 4x4 pickup, 1985-86 V57=D06 V8=Y

Light truck group 8103
Nissan pickup 104.3, 1986-93
Compact pickup truck
Wheelbase 104.3
8107 Nissan standard-bed pickup, 1986-93 V3=6 V57=D11 V8=S,H
8108 Nissan standard-bed 4x4 pickup, 1986-93 V3=6 V57=D11 V8=Y

Light truck group 8104
Nissan pickup 116.1, 1986-93
Compact pickup truck
Wheelbase 116.1
8109 Nissan long-bed pickup, 1986-93 V3=6 V57=D12 V8=S,H
8110 Nissan King Cab pickup, 1986-93 V3=6 V57=D16 V8=S,H
8111 Nissan long-bed 4x4 pickup, 1986-93 V3=6 V57=D12 V8=Y
8112 Nissan King Cab 4x4 pickup, 1986-93 V3=6 V57=D16 V8=Y

Light truck group 8105
Nissan Pathfinder, 1987-93
Compact SUV
Wheelbase 104.3
8113 Nissan Pathfinder 2dr 4x4, 1987-90 V3=8 V57=D14,D16 V8=Y
8113 Nissan Pathfinder 2dr 4x4, 1987-89 V3=6 V57=D14 V8=Y
8115 Nissan Pathfinder 2dr, 1989-90 V3=8 V57=D14,D16 V8=S
8116 Nissan Pathfinder 4dr, 1990-93 V3=8 V57=D17 V8=S
8117 Nissan Pathfinder 4dr 4x4, 1990-93 V3=8 V57=D17 V8=Y

Light truck group 8106
Nissan van, 1987-90
Compact van
Wheelbase 92.5
8114 Nissan van, 1987-90 V3=8 V57=C26 V8=S

Light truck group 8107
Nissan Quest, 1993
Compact van
Wheelbase 112.2
8118 Nissan Quest, 1993 V13=4N2 V57=N11

Isuzu Light Truck Groups

Light truck group 8201
Isuzu P'UP 104.3, 1985-87
Compact pickup truck
Wheelbase 104.3
8201 Isuzu P'UP standard bed, 1985-87 V3=A V4=B V57=L14
8202 Isuzu 4x4 P'UP standard bed, 1985-87 V3=A V4=B V57=R14

Light truck group 8202
Isuzu P'UP 117.9, 1985-87
Compact pickup truck
Wheelbase 117.9
8203 Isuzu P'UP long bed, 1985-87 V3=A V4=C V57=L14
8204 Isuzu 4x4 P'UP long bed, 1985-87 V3=A V4=C V57=R14
8206 Isuzu P'UP Space Cab, 1986-87 V3=A V4=C V57=L16
8207 Isuzu 4x4 P'UP Space Cab, 1986-87 V3=A V4=C V57=R16

Light truck group 8203
Isuzu Trooper II 104.3, 1985-91
Compact SUV
Wheelbase 104.3
8205 Isuzu Trooper II 4x4, 1985-88 V3=A V4=C V57=H15,H18
8205 Isuzu Trooper II 4x4, 1985-91 V3=C V4=C V57=H55,H58
8205 Isuzu Trooper II 4x4, 1987-91 V13=LES V4=C V57=H55,H58

Light truck group 8204
Isuzu P'UP 105.6, 1988-93
Compact pickup truck
Wheelbase 105.6
8208 Isuzu P'UP standard bed, 1988-93 V3=A V4=C V57=L11
8208 Isuzu P'UP standard bed, 1990-93 V13=4S1 V4=C V57=L11
8209 Isuzu 4x4 P'UP standard bed, 1988-93 V3=A V4=C V57=R11
8209 Isuzu 4x4 P'UP standard bed, 1991-93 V13=4S1 V4=C V57=R11

Light truck group 8205
Isuzu P'UP 119.2, 1988-93
Compact pickup truck
Wheelbase 119.2
8210 Isuzu P'UP long bed, 1988-93 V3=A V4=C V57=L14
8210 Isuzu P'UP long bed, 1992-93 V13=4S1 V4=C V57=L14
8211 Isuzu 4x4 P'UP long bed, 1988-93 V3=A V4=C V57=R14
8211 Isuzu 4x4 P'UP long bed, 1992-93 V13=4S1 V4=C V57=R14
8212 Isuzu P'UP Space Cab, 1988-93 V3=A V4=C V57=L16
8212 Isuzu P'UP Space Cab, 1992-93 V13=4S1 V4=C V57=L16
8213 Isuzu 4x4 P'UP Space Cab, 1988-93 V3=A V4=C V57=R16
8213 Isuzu 4x4 P'UP Space Cab, 1992-93 V13=4S1 V4=C V57=R16
8214 Isuzu 1-ton P'UP long bed, 1988-93 V3=A V4=C-E V57=L34
8214 Isuzu 1-ton P'UP long bed, 1992-93 V13=4S1 V4=C-E V57=L34

Light truck group 8206
Isuzu Amigo, 1989-93
Compact SUV
Wheelbase 91.7
8215 Isuzu Amigo, 1989-91 V3=A V4=B,C V57=L01
8215 Isuzu Amigo, 1992-93 V3=C V4=B,C V57=G07
8216 Isuzu Amigo 4x4, 1989-91 V3=A V4=B,C V57=R01
8216 Isuzu Amigo 4x4, 1992-93 V3=C V4=B,C V57=Y07

Light truck group 8207
Isuzu Trooper II 90.6, 1989-90
Compact SUV
Wheelbase 90.6
8217 Isuzu Trooper II 2dr 4x4, 1989-90 V3=C V4=C V57=H57

Light truck group 8208
Isuzu Rodeo, 1991-93
Compact SUV
Wheelbase 108.7
8218 Isuzu Rodeo, 1991-93 V13=4S2 V4=C V57=G58
8219 Isuzu Rodeo 4x4, 1991-93 V13=4S2 V4=C V57=Y58

Light truck group 8209
Isuzu Trooper 4dr 108.7, 1992-93
Compact SUV
Wheelbase 108.7
8220 Isuzu Trooper 4dr 4x4, 1992-93 V3=C V4=D V57=H58

Light truck group 8210
Isuzu Trooper 2dr 91.7, 1993
Compact SUV
Wheelbase 91.7
8221 Isuzu Trooper 2dr 4x4, 1993 V3=C V57=H57

Mazda Light Truck Groups

Light truck group 8301
Mazda pickup 108.7, 1986-93
Compact pickup truck
Wheelbase 108.7 (109.3 with 4x4)
8301 Mazda B2000/2200/2600 pickup short bed, 1986-93 V35=2UF V6=1
8304 Mazda B2000/2200/2600 4x4 pickup short bed, 1987-93 V35=2UF V6=4

Light truck group 8302
Mazda pickup 117.5, 1986-93
Compact pickup truck
Wheelbase 117.5 (118.1 with 4x4)
8302 Mazda B2000/2200/2600 pickup long bed, 1986-93 V35=2UF V6=2
8303 Mazda B2000/2200/2600 pickup "cab plus", 1986-93 V35=2UF V6=3
8305 Mazda B2000/2200/2600 4x4 pickup long bed, 1987-93 V35=2UF V6=5
8306 Mazda B2000/2200/2600 4x4 pickup "cab plus", 1987-93 V35=2UF V6=6

Light truck group 8303
Mazda MPV, 1989-93
Compact van
Wheelbase 110.4
8307 Mazda MPV cargo van, 1989-93 V35=2LV V68=621
8308 Mazda MPV wagon, 1989-93 V35=3LV V68=521,522
8309 Mazda MPV 4x4 wagon, 1989-93 V35=3LV V68=523

Subaru Light Truck Groups

Light truck group 8401
Subaru Brat, 1985-87
Pickup car
Wheelbase 96.3
8401 Subaru Brat 4x4, 1985 V35=2AT
8401 Subaru Brat 4x4, 1986-87 V35=3AU

Toyota Light Truck Groups

Light truck group 8501
Toyota pickup 103, 1985-93
Compact pickup truck
Wheelbase 103.0 (103.3 with 4x4)
8501 Toyota pickup short bed, 1985-88 V3=4 V5=N V6=5 V7=0
8501 Toyota pickup short bed, 1989-93 V3=4 V57=N81
8501 Toyota pickup short bed, 1992-93 V13=4TA V57=N81
8502 Toyota 4x4 pickup short bed, 1985 V3=4 V5=N V6=6 V7=0
8502 Toyota 4x4 pickup short bed, 1986-88 V3=4 V5=N V6=6 V7=3
8502 Toyota 4x4 pickup short bed, 1989-93 V3=4 V57=N01
8502 Toyota 4x4 pickup short bed, 1992-93 V13=4TA V57=N01

Light truck group 8502
Toyota pickup 112.2, 1985-93
Compact pickup truck
Wheelbase 112.2
8503 Toyota pickup long bed, 1985-88 V3=4 V5=N V6=5 V7=5
8503 Toyota pickup long bed, 1989-93 V3=4 V57=N82
8504 Toyota 4x4 pickup long bed, 1985 V3=4 V5=N V6=6 V7=5
8504 Toyota 4x4 pickup long bed, 1986-88 V3=4 V5=N V6=6 V7=4
8504 Toyota 4x4 pickup long bed, 1989-93 V3=4 V57=N02
8505 Toyota Xtracab pickup, 1985-88 V3=4 V5=N V6=5 V7=6
8505 Toyota Xtracab pickup, 1985 V3=4 V5=N V6=5 V7=9
8506 Toyota 4x4 Xtracab pickup, 1985 V3=4 V5=N V6=6 V7=6
8506 Toyota 4x4 Xtracab pickup, 1986-88 V3=4 V5=N V6=6 V7=7

Light truck group 8503
Toyota 4Runner, 1985-93
Compact SUV
Wheelbase 103.0
8507 Toyota 4Runner 4x4, 1985-89 V3=3 V5=N V6=6
8507 Toyota 4Runner 4x4, 1985 V3=4 V5=N V6=6 V7=1
8507 Toyota 4Runner 4x4, 1986-89 V3=4 V5=N V6=6 V7=2
8507 Toyota 4Runner 4x4, 1990-93 V3=3 V5=N V6=3
8515 Toyota 4Runner, 1990-93 V3=3 V5=N V6=2

Light truck group 8504
Toyota van 88.0, 1985-89
Compact van
Wheelbase 88.0
8508 Toyota passenger van, 1985-89 V3=3 V5=R V6=2
8509 Toyota cargo van, 1985-89 V3=4 V5=R V6=2 V7=7-9
8512 Toyota passenger 4x4 van, 1987-89 V3=3 V5=R V6=3
8513 Toyota cargo 4x4 van, 1987-89 V3=4 V5=R V6=3 V7=4

Light truck group 8505
Toyota Land Cruiser 107.5, 1985-90
Full-sized SUV
Wheelbase 107.5
8510 Toyota Land Cruiser 4x4, 1985-87 V3=3 V5=J V6=6 V7=0
8510 Toyota Land Cruiser 4x4, 1986-87 V3=4 V5=J V6=6 V7=0
8510 Toyota Land Cruiser 4x4, 1988-90 V3=3 V5=J V6=6 V7=2

Light truck group 8506
Toyota pickup 121.5, 1986-93
Compact pickup truck
Wheelbase 121.5 (121.9 with 4x4)
8511 Toyota pickup Xtracab long bed, 1986-88 V3=4 V5=N V6=7 V7=0
8511 Toyota pickup Xtracab long bed, 1989-93 V3=4 V57=N93
8514 Toyota 4x4 pickup Xtracab long bed, 1989-93 V3=4 V57=N13
8514 Toyota 4x4 pickup Xtracab long bed, 1992-93 V13=4TA V57=N13

Light truck group 8507
Toyota Land Cruiser 112.2, 1991-93
Full-sized SUV
Wheelbase 112.2
8516 Toyota Land Cruiser 4x4, 1991-92 V3=3 V5=J V6=8 V7=0
8516 Toyota Land Cruiser 4x4, 1993 V3=3 V5=J V6=8 V7=1

Light truck group 8508
Toyota Previa, 1991-93
Compact van
Wheelbase 112.8
8517 Toyota Previa, 1991-93 V3=3 V5=C V6=1 V7=1,2
8518 Toyota Previa 4x4, 1991-93 V3=3 V5=C V6=2 V7=1,2

Light truck group 8509
Toyota T100 pickup, 1993
Full-sized pickup truck
Wheelbase 121.8
8519 Toyota T100 pickup, 1993 V3=4 V57=D10 V8 NE B
8520 Toyota T100 1-ton pickup, 1993 V3=4 V57=D10 V8=B
8521 Toyota T100 4x4 pickup, 1993 V3=4 V57=D20

Mitsubishi Light Truck Groups

Light truck group 8601
Mitsubishi Mighty Max pickup 109, 1985-86
Compact pickup truck
Wheelbase 109.4 (109.8 with 4x4)
7121 Dodge Ram-50 pickup, 1985-86 V3=7 V5=P V7=4
7122 Dodge Ram-50 4x4 pickup, 1985-86 V3=7 V5=K V7=4
8601 Mitsubishi Mighty Max, 1985-86 V3=7 V5=P V7=4
8602 Mitsubishi Mighty Max 4x4, 1985-86 V3=7 V5=K V7=4

Light truck group 8602
Mitsubishi Montero 2dr 92.5, 1985-91
Compact SUV
Wheelbase 92.5
7123 Dodge Raider 2dr 4x4, 1987-90 V1=J V3=4,7 V5=J V7=2,3
8603 Mitsubishi Montero 2dr 4x4, 1985-91 V3=4,7 V5=J V7=2,3

Light truck group 8603
Mitsubishi Mighty Max pickup 105, 1987-93
Compact pickup truck
Wheelbase 105.1 (105.5 with 4x4)
7124 Dodge Ram-50 pickup, 1987-92 V1=J V3=7 V5=L V7=4
7124 Dodge Ram-50 pickup, 1993 V1=J V3=7 V5=S V7=1
7125 Dodge Ram-50 4x4 pickup, 1987-92 V1=J V3=7 V5=M V7=4
7125 Dodge Ram-50 4x4 pickup, 1993 V1=J V3=7 V5=T V7=1
8604 Mitsubishi Mighty Max, 1987-92 V3=7 V5=L V7=4
8604 Mitsubishi Mighty Max, 1993 V3=7 V5=S V7=1
8605 Mitsubishi Mighty Max 4x4, 1987-92 V3=7 V5=M V7=4
8605 Mitsubishi Mighty Max 4x4, 1993 V3=7 V5=T V7=1

Light truck group 8604
Mitsubishi Mighty Max pickup 116, 1987-93
Compact pickup truck
Wheelbase 116.1 (116.5 with 4x4)
7126 Dodge Ram-50 pickup long bed, 1987-92 V3=7 V5=L V7=9
7126 Dodge Ram-50 pickup long bed, 1993 V3=7 V5=S V7=2
7127 Dodge Ram-50 4x4 pickup long bed, 1987-92 V3=7 V5=M V7=9
7127 Dodge Ram-50 4x4 pickup long bed, 1993 V3=7 V5=T V7=2
7128 Dodge Ram-50 pickup extended cab, 1987-92 V3=7 V5=L V7=5
7128 Dodge Ram-50 pickup extended cab, 1993 V3=7 V5=S V7=3
7129 Dodge Ram-50 4x4 pickup extended cab, 1987-92 V3=7 V5=M V7=5
7129 Dodge Ram-50 4x4 pickup extended cab, 1993 V3=7 V5=T V7=3
8606 Mitsubishi Mighty Max long bed, 1987-92 V3=7 V5=L V7=9
8606 Mitsubishi Mighty Max long bed, 1993 V3=7 V5=S V7=2
8607 Mitsubishi Mighty Max 4x4 long bed, 1987-92 V3=7 V5=M V7=9
8607 Mitsubishi Mighty Max 4x4 long bed, 1993 V3=7 V5=T V7=2
8608 Mitsubishi Mighty Max extended cab, 1987-92 V3=7 V5=L V7=5
8608 Mitsubishi Mighty Max extended cab, 1993 V3=7 V5=S V7=3
8609 Mitsubishi Mighty Max 4x4 extended cab, 1987-92 V3=7 V5=M V7=5
8609 Mitsubishi Mighty Max 4x4 extended cab, 1993 V3=7 V5=T V7=3

Light truck group 8605
Mitsubishi wagon/van, 1987-90
Compact van
Wheelbase 88.0
8610 Mitsubishi van, 1987-90 V3=7 V5=N V7=3
8611 Mitsubishi wagon, 1987-90 V3=4 V5=N V7=1,4

Light truck group 8606
Mitsubishi Montero 4dr 106.1, 1989-91
Compact SUV
Wheelbase 106.1
8612 Mitsubishi Montero 4dr 4x4, 1989-91 V3=4 V5=J V7=1

Light truck group 8607
Mitsubishi Montero 4dr 107.3, 1992-93
Compact SUV
Wheelbase 107.3
8613 Mitsubishi Montero 4dr 4x4, 1992 V3=4 V5=K V7=1
8613 Mitsubishi Montero 4dr 4x4, 1993 V3=4 V5=R V7=1

Suzuki Light Truck Groups

Light truck group 8701
Suzuki Samurai, 1985-93
Compact SUV
Wheelbase 79.9
8701 Suzuki Samurai 4x4, 1985-93 V3=3,4 V4=J V5=A(?),C
8706 Suzuki Samurai, 1991-93 V3=3,4 V4=J V5=D

Light truck group 8702
Suzuki Sidekick 2dr 86.6, 1989-93
Compact SUV
Wheelbase 86.6
7643 Chevrolet Geo Tracker 4x4, 1989 V13=JGC V4=B V57=J18
7643 Chevrolet Geo Tracker 4x4, 1990-93 V13=2CN V4=B V57=J18
7659 Chevrolet Geo Tracker, 1991-93 V13=2CN V4=B V57=E18
8702 Suzuki Sidekick 2dr, 1989-93 V3=3,4 V45=TC
8703 Suzuki Sidekick 2dr 4x4, 1989-93 V3=3,4 V45=TA

Light truck group 8703
Suzuki Sidekick 4dr 97.6, 1991-93
Compact SUV
Wheelbase 97.6
8704 Suzuki Sidekick 4dr, 1991-93 V3=3,4 V45=TE
8705 Suzuki Sidekick 4dr 4x4, 1991-93 V3=3,4 V45=TD

Daihatsu Light Truck Groups

Light truck group 8801
Daihatsu Rocky, 1990-92
Compact SUV
Wheelbase 85.6
8801 Daihatsu Rocky, 1990-92 V3=2 V56=F3

APPENDIX D

CURB WEIGHT, TRACK WIDTH AND WHEELBASE OF PASSENGER CARS

CG	=	fundamental car group (see Appendix B)
MM2	=	make-model code (see Appendix B)
BODYTYP	=	body style
WT85	=	curb weight (pounds) in model year 1985. Source: Polk's National Vehicle Population Profile, edited for consistency from year to year and across related make-models
WHLBAS	=	wheelbase (inches). Source: Automotive News Market Data Books
TRACK	=	track width (inches). Source: Automotive News Market Data Books

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
AMC EAGLE	111	109	4-DOOR	3385	3382	3372	.	.	.	.	.	.	109.3	58.6
AMC EAGLE	111	109	STA WAGN	3419	3418	3399	3502	.	.	.	.	.	109.3	58.6
CHRY 5TH AV RWD	614	610	4-DOOR	3750	3744	3743	3759	3770	.	.	.	.	112.7	59.8
DODGE DIPLOMAT	614	707	4-DOOR	3592	3596	3601	3631	3615	.	.	.	.	112.7	59.8
PLYM GRAN FURY	614	904	4-DOOR	3561	3561	3571	3576	3586	.	.	.	.	112.7	59.8
DODGE OMNI 4DR	615	708	4-DOOR	2224	2221	2240	2259	2296	2299	.	.	.	99.2	55.9
PLYM HORIZON 4DR	615	908	4-DOOR	2214	2213	2240	2259	2299	2299	.	.	.	99.2	55.9
DODGE OMNI 2DR	616	708	2-DOOR	2311	2316	2319	.	.	.	.	.	.	96.7	56.0
PLYM HORIZON 2DR	616	908	2-DOOR	2287	2292	2303	.	.	.	.	.	.	96.7	56.0
CHRY LEBARON	618	616	CONVRTBL	2662	2666	2786	2867	2937	3158	3025	3187	2976	100.3	57.3
CHRY LEBARON	618	616	2-DOOR	2547	2563	2642	2773	2822	2959	2883	3042	2861	100.3	57.3
CHRY LEBARON	618	616	4-DOOR	2576	2585	2628	2767	.	.	.	.	.	100.3	57.3
CHRY LEBARON	618	616	STA WAGN	2742	2740	2748	2748	.	.	.	.	.	100.3	57.3
DODGE ARIES	618	711	2-DOOR	2406	2450	2423	2440	2458	.	.	.	.	100.3	57.3
DODGE ARIES	618	711	4-DOOR	2418	2453	2431	2459	2471	.	.	.	.	100.3	57.3
DODGE ARIES	618	711	STA WAGN	2533	2552	2524	2564	.	.	.	.	.	100.3	57.3
DODGE 600 2DR	618	714	CONVRTBL	2628	2627	.	.	.	.	.	.	.	100.3	57.3
DODGE 600 2DR	618	714	2-DOOR	2545	2564	.	.	.	.	.	.	.	100.3	57.3
PLYM RELIANT	618	911	2-DOOR	2405	2449	2421	2440	2457	.	.	.	.	100.3	57.3
PLYM RELIANT	618	911	4-DOOR	2419	2453	2406	2441	2472	.	.	.	.	100.3	57.3
PLYM RELIANT	618	911	STA WAGN	2532	2547	2521	2573	.	.	.	.	.	100.3	57.3
CHRY E-CLASS/NY	619	614	4-DOOR	2781	2746	2748	2826	.	.	.	.	.	103.3	57.3
CHRY LEBARON GTS	619	616	4-DOOR	2665	2668	2681	2754	2810	.	.	.	.	103.3	57.4
DODGE 600 4DR	619	714	4-DOOR	2609	2613	2612	2626	.	.	.	.	.	103.3	57.3
DODGE LANCER	619	716	4-DOOR	2677	2686	2688	2720	2757	.	.	.	.	103.3	57.4
PLYM CARAVELLE	619	907	4-DOOR	2603	2609	2607	2627	.	.	.	.	.	103.3	57.4
CHRY LASER	620	615	2-DOOR	2657	2657	.	.	.	.	.	.	.	97.0	57.4
DODGE DAYTONA	620	715	2-DOOR	2643	2628	2747	2732	2857	2874	2840	2851	2810	97.0	57.4
DODGE SHADOW	620	717	CONVRTBL	.	.	.	.	.	.	2888	2924	2884	97.0	57.4
DODGE SHADOW	620	717	2-DOOR	.	.	2529	2538	2624	2625	2629	2651	2644	97.0	57.4
DODGE SHADOW	620	717	4-DOOR	.	.	2553	2545	2655	2661	2640	2675	2638	97.0	57.4
PLYM SUNDANCE	620	917	2-DOOR	.	.	2525	2532	2630	2630	2623	2663	2626	97.0	57.4
PLYM SUNDANCE	620	917	4-DOOR	.	.	2553	2545	2666	2667	2665	2674	2630	97.0	57.4
CHRY NY C	621	618	4-DOOR	.	.	.	3255	3273	3279	3286	3273	3231	104.3	57.6
DODGE DYNASTY	621	718	4-DOOR	.	.	.	3002	3080	3102	3121	3090	3027	104.3	57.6
CHRY LEBARON 90-93	622	616	4-DOOR	.	.	.	.	.	3064	3038	2962	2952	103.3	57.4
DODGE SPIRIT	622	719	4-DOOR	.	.	.	.	2822	2854	2848	2808	2784	103.3	57.4
PLYM ACCLAIM	622	919	4-DOOR	.	.	.	.	2803	2858	2844	2815	2782	103.3	57.4
CHRY 5TH AVE FWD	623	620	4-DOOR	.	.	.	.	.	3482	3430	3393	3345	109.5	57.6
DODGE VIPER	624	713	CONVRTBL	.	.	.	.	.	.	.	3476	3476	96.2	60.1
CHRY CONCORDE	625	641	4-DOOR	.	.	.	.	.	.	.	.	3389	113.0	62.0
DODGE INTREPID	625	741	4-DOOR	.	.	.	.	.	.	.	.	3306	113.0	62.0
EAGLE VISION	625	1041	4-DOOR	.	.	.	.	.	.	.	.	3354	113.0	62.0
FORD LTD	1226	1206	4-DOOR	3012	3001	.	.	.	.	.	.	.	105.6	56.8
FORD LTD	1226	1206	STA WAGN	3107	3108	.	.	.	.	.	.	.	105.6	56.8
MERC MARQUIS	1226	1406	4-DOOR	3000	3007	.	.	.	.	.	.	.	105.6	56.8
MERC MARQUIS	1226	1406	STA WAGN	3115	3112	.	.	.	.	.	.	.	105.6	56.8
FORD MUSTANG	1227	1203	CONVRTBL	.	.	3085	3184	3207	3196	3273	3278	3129	100.5	56.8
FORD MUSTANG	1227	1203	2-DOOR	2719	2771	2873	2958	2949	3004	3045	3131	2950	100.5	56.8
MERC CAPRI U.S.	1227	1403	2-DOOR	2869	2906	.	.	.	.	.	.	.	100.5	56.8

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
FORD CROWN VIC	1228	1216	2-DOOR	3699	3708	3733	.	.	.	.	.	.	114.3	62.1
FORD CROWN VIC	1228	1216	4-DOOR	3746	3748	3761	3813	3762	3823	3832	3764	3796	114.3	62.1
FORD CROWN VIC	1228	1216	STA WAGN	3904	4038	3938	4023	3935	4015	4060	.	.	114.3	62.1
MERC GRAND MARQUIS	1228	1416	2-DOOR	3758	3782	3764	.	.	.	.	.	.	114.3	62.1
MERC GRAND MARQUIS	1228	1416	4-DOOR	3800	3818	3800	3838	3854	3839	3807	3777	3803	114.3	62.1
MERC GRAND MARQUIS	1228	1416	STA WAGN	3967	3993	4002	4019	3935	3944	4016	.	.	114.3	62.1
LINC TOWN CAR	1230	1301	4-DOOR	4027	4038	4076	4083	4054	4040	4042	4025	4045	117.3	62.1
FORD ESCORT -90	1231	1213	2-DOOR	2115	2188	2227	2262	2288	2335	.	.	.	94.2	55.4
FORD ESCORT -90	1231	1213	4-DOOR	2185	2212	2225	2302	2313	2355	.	.	.	94.2	55.4
FORD ESCORT -90	1231	1213	STA WAGN	2222	2244	2274	2312	2312	2411	.	.	.	94.2	55.4
FORD EXP	1231	1214	2-DOOR	2194	2336	2378	2348	.	.	.	.	.	94.2	55.4
MERC LYNX	1231	1413	2-DOOR	2121	2189	2242	.	.	.	.	.	.	94.2	55.4
MERC LYNX	1231	1413	4-DOOR	2192	2214	2268	.	.	.	.	.	.	94.2	55.4
MERC LYNX	1231	1413	STA WAGN	2225	2256	2277	.	.	.	.	.	.	94.2	55.4
LINC MARK7	1232	1302	2-DOOR	3615	3684	3760	3776	3774	3798	3802	3779	.	108.5	58.7
LINC CONTINTL -87	1232	1305	4-DOOR	3790	3778	3804	.	.	.	.	.	.	108.5	58.7
FORD T-BIRD -88	1233	1204	2-DOOR	3151	3099	3242	3321	.	.	.	.	.	104.0	58.3
MERC COUGAR -88	1233	1404	2-DOOR	3127	3117	3186	3310	.	.	.	.	.	104.0	58.3
FORD TEMPO	1234	1215	2-DOOR	2409	2355	2518	2547	2533	2531	2736	2538	2511	99.9	56.2
FORD TEMPO	1234	1215	4-DOOR	2468	2420	2559	2608	2602	2592	2637	2618	2572	99.9	56.2
MERC TOPAZ	1234	1415	2-DOOR	2433	2411	2498	2572	2558	2546	2546	2546	2540	99.9	56.2
MERC TOPAZ	1234	1415	4-DOOR	2488	2459	2584	2628	2619	2609	2608	2619	2605	99.9	56.2
FORD TAURUS	1235	1217	4-DOOR	.	2948	3008	3054	3044	3102	3125	3131	3119	106.0	61.0
FORD TAURUS	1235	1217	STA WAGN	.	3180	3203	3237	3203	3263	3290	3282	3284	106.0	61.0
MERC SABLE	1235	1417	4-DOOR	.	3054	3097	3151	3138	3156	3192	3160	3152	106.0	61.0
MERC SABLE	1235	1417	STA WAGN	.	3228	3272	3262	3238	3288	3340	3312	3307	106.0	61.0
LINC CONTINTL 88-	1236	1305	4-DOOR	.	.	.	3634	3633	3634	3634	3627	3606	109.0	61.7
FORD T-BIRD 89-	1237	1204	2-DOOR	.	.	.	.	3609	3634	3607	3582	3566	113.0	60.9
LINC MARK8	1237	1302	2-DOOR	.	.	.	.	.	.	.	.	3741	113.0	60.9
MERC COUGAR 89-	1237	1404	2-DOOR	.	.	.	.	3562	3620	3617	3606	3526	113.0	60.9
CHEV CHEVETTE 2DR	1838	2013	2-DOOR	2085	2080	2078	.	.	.	.	.	.	94.3	51.2
PONT T1000 2DR	1838	2213	2-DOOR	2083	2114	2084	.	.	.	.	.	.	94.3	51.2
BUICK LESABRE RWD	1839	1802	2-DOOR	3778	.	.	.	.	.	.	.	.	115.9	61.2
BUICK LESABRE RWD	1839	1802	4-DOOR	3799	.	.	.	.	.	.	.	.	115.9	61.2
BUICK ROADMSTR 4DR	1839	1804	4-DOOR	.	.	.	.	.	.	.	4095	4105	115.9	61.2
CHEV CAPRICE SDN	1839	2002	2-DOOR	3607	3625	3593	.	.	.	.	.	.	115.9	61.2
CHEV CAPRICE SDN	1839	2002	4-DOOR	3617	3636	3624	3655	3735	3859	3942	3972	3789	115.9	61.2
OLDS DELTA 88 RWD	1839	2102	2-DOOR	3690	.	.	.	.	.	.	.	.	115.9	61.2
OLDS DELTA 88 RWD	1839	2102	4-DOOR	3748	.	.	.	.	.	.	.	.	115.9	61.2
PONT PARISIEN SDN	1839	2202	4-DOOR	3793	3662	.	.	.	.	.	.	.	115.9	61.2
BUICK ESTATE WAGON	1840	1802	STA WAGN	4239	4226	4222	4112	4246	4339	4415	.	.	115.9	63.1
BUICK ROADMSTR SW	1840	1804	STA WAGN	.	.	.	.	.	.	.	4468	4508	115.9	63.1
CHEV CAPRICE SW	1840	2002	STA WAGN	4177	4095	4122	4158	4192	4324	4354	4402	4213	115.9	63.1
OLDS CUST CRUISER	1840	2102	STA WAGN	4108	4085	4049	4136	4221	4327	4435	4394	.	115.9	63.1
PONT SAFARI SW	1840	2202	STA WAGN	4060	4103	4191	4182	4208	.	.	.	.	115.9	63.1
CADI FLTWD BROUGHM	1842	1903	2-DOOR	3978	.	.	.	.	.	.	.	.	121.5	61.2
CADI FLTWD BROUGHM	1842	1903	4-DOOR	4027	4076	4073	4181	4283	4289	4275	4277	4418	121.5	61.2
CHEV CHEVETTE 4DR	1843	2013	4-DOOR	2146	2140	2137	.	.	.	.	.	.	97.3	51.2
PONT T1000 4DR	1843	2213	4-DOOR	2142	2173	2143	.	.	.	.	.	.	97.3	51.2
OLDS CUTLS 4DR 85	1844	2101	4-DOOR	3278	.	.	.	.	.	.	.	.	108.1	58.2
PONT BONNEVIL RWD	1844	2202	4-DOOR	3263	3218	.	.	.	.	.	.	.	108.1	58.2

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
BUIC REGAL RWD	1845	1810	2-DOOR	3190	3294	3257	.	.	.	.	.	.	108.1	58.2
CHEV MONTE CARLO	1845	2010	2-DOOR	3196	3228	3270	3258	.	.	.	.	.	108.1	58.2
OLDS CUTLASS RWD	1845	2101	2-DOOR	3261	3320	3261	3203	.	.	.	.	.	108.1	58.2
OLDS CUTLASS RWD	1845	2101	4-DOOR	.	3335	3279	.	.	.	.	.	.	108.1	58.2
PONT GRN PRIX RWD	1845	2210	2-DOOR	3290	3310	3336	.	.	.	.	.	.	108.1	58.2
BUICK RIVIERA 85	1846	1805	CONVRTBL	3977	.	.	.	.	.	.	.	.	114.0	59.7
BUICK RIVIERA 85	1846	1805	2-DOOR	3851	.	.	.	.	.	.	.	.	114.0	59.7
CADI ELDORADO 85	1846	1905	CONVRTBL	3915	.	.	.	.	.	.	.	.	114.0	60.0
CADI ELDORADO 85	1846	1905	2-DOOR	3734	.	.	.	.	.	.	.	.	114.0	60.0
CADI SEVILLE 85	1846	1914	4-DOOR	3803	.	.	.	.	.	.	.	.	114.0	60.0
OLDS TORONADO 85	1846	2105	2-DOOR	3854	.	.	.	.	.	.	.	.	114.0	59.7
BUICK SKYLARK X	1847	1815	4-DOOR	2605	.	.	.	.	.	.	.	.	104.9	57.9
CHEV CITATION	1847	2015	2-DOOR	2541	.	.	.	.	.	.	.	.	104.9	57.9
CHEV CITATION	1847	2015	4-DOOR	2547	.	.	.	.	.	.	.	.	104.9	57.9
BUICK SKYHAWK J	1848	1816	2-DOOR	2345	2345	2360	2349	2420	.	.	.	.	101.2	55.3
BUICK SKYHAWK J	1848	1816	4-DOOR	2396	2393	2399	2409	2469	.	.	.	.	101.2	55.3
BUICK SKYHAWK J	1848	1816	STA WAGN	2470	2468	2478	2476	2551	.	.	.	.	101.2	55.3
CADI CIMARRON	1848	1916	4-DOOR	2610	2720	2667	2704	.	.	.	.	.	101.2	55.3
CHEV CAVALIER	1848	2016	CONVRTBL	2511	2521	2610	2665	2729	.	2560	2821	2764	101.2	55.3
CHEV CAVALIER	1848	2016	2-DOOR	2332	2389	2451	2433	2466	2506	2497	2534	2536	101.2	55.3
CHEV CAVALIER	1848	2016	4-DOOR	2347	2351	2356	2371	2423	2491	2491	2623	2528	101.2	55.3
CHEV CAVALIER	1848	2016	STA WAGN	2415	2420	2413	2429	2500	2602	2601	2567	2643	101.2	55.3
OLDS FIRENZA	1848	2116	2-DOOR	2405	2360	2363	2327	.	.	.	.	.	101.2	55.3
OLDS FIRENZA	1848	2116	4-DOOR	2395	2410	2386	2381	.	.	.	.	.	101.2	55.3
OLDS FIRENZA	1848	2116	STA WAGN	2465	2462	2440	2438	.	.	.	.	.	101.2	55.3
PONT SUNBIRD J	1848	2216	CONVRTBL	2542	2579	2581	2577	2737	2700	2683	2740	2713	101.2	55.3
PONT SUNBIRD J	1848	2216	2-DOOR	2327	2383	2384	2420	2393	2500	2508	2551	2546	101.2	55.3
PONT SUNBIRD J	1848	2216	4-DOOR	2380	2406	2376	2424	2405	2500	2505	2543	2543	101.2	55.3
PONT SUNBIRD J	1848	2216	STA WAGN	2448	2466	2418	2427	.	.	.	.	.	101.2	55.3
CHEV CAMARO	1849	2009	CONVRTBL	.	.	3350	3499	3389	3380	3360	3324	3298	101.0	60.8
CHEV CAMARO	1849	2009	2-DOOR	3056	3132	3138	3147	3120	3217	3217	3204	3301	101.0	60.8
PONT FIREBIRD	1849	2209	CONVRTBL	.	.	.	.	.	.	3377	3393	.	101.0	60.8
PONT FIREBIRD	1849	2209	2-DOOR	3136	3185	3317	3240	3333	3221	3213	3203	3337	101.0	60.8
BUICK CENTURY FWD	1850	1817	2-DOOR	2783	2755	2812	2794	2823	2940	2913	2952	2896	104.9	57.8
BUICK CENTURY FWD	1850	1817	4-DOOR	2816	2791	2798	2823	2860	2947	2946	2946	2947	104.9	57.8
BUICK CENTURY FWD	1850	1817	STA WAGN	3008	2979	3003	2998	3015	3154	3152	3135	3091	104.9	57.8
CHEV CELEBRITY	1850	2017	2-DOOR	2732	2731	2730	2770	.	.	.	.	.	104.9	57.9
CHEV CELEBRITY	1850	2017	4-DOOR	2757	2759	2750	2799	2801	.	.	.	.	104.9	57.9
CHEV CELEBRITY	1850	2017	STA WAGN	2904	2912	2904	2948	2956	3135	.	.	.	104.9	57.9
OLDS CIERA	1850	2117	2-DOOR	2787	2772	2743	2861	2820	2919	2920	.	.	104.9	57.8
OLDS CIERA	1850	2117	4-DOOR	2817	2814	2747	2803	2846	2945	2948	3048	2919	104.9	57.8
OLDS CIERA	1850	2117	STA WAGN	2992	2977	2941	3035	3001	3152	3094	3116	3116	104.9	57.8
PONT 6000	1850	2217	2-DOOR	2790	2786	2761	.	.	.	.	.	.	104.9	57.9
PONT 6000	1850	2217	4-DOOR	2874	2860	2815	2813	2853	2867	2836	.	.	104.9	57.9
PONT 6000	1850	2217	STA WAGN	2964	2995	2984	2974	3000	3148	3164	.	.	104.9	57.9
CHEV CORVETTE	1851	2004	CONVRTBL	.	3235	3299	3299	3263	3301	3333	3375	3377	96.2	60.0
CHEV CORVETTE	1851	2004	2-DOOR	3216	3239	3229	3229	3223	3289	3316	3332	3336	96.2	60.0
BUICK LESABRE FWD	1852	1802	2-DOOR	.	3176	3213	3222	3250	3254	3267	.	.	110.8	60.1
BUICK LESABRE FWD	1852	1802	4-DOOR	.	3208	3244	3274	3282	3285	3286	3431	3430	110.8	60.1
BUICK ELECTRA FWD	1852	1803	2-DOOR	3216	3289	3282	.	3337	.	.	.	.	110.8	60.1
BUICK ELECTRA FWD	1852	1803	4-DOOR	3264	3329	3312	3346	3339	3387	3597	3558	3565	110.8	60.1
CADI DEVILLE FWD	1852	1903	2-DOOR	3326	3313	3225	3361	3476	3474	3523	3521	3519	110.8	60.1

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
CADI DEVILLE FWD	1852	1903	4-DOOR	3405	3375	3301	3411	3556	.	.	.	.	110.8	60.1
OLDS DELTA 88 FWD	1852	2102	2-DOOR	.	3168	3085	3180	3235	3235	3267	.	.	110.8	60.1
OLDS DELTA 88 FWD	1852	2102	4-DOOR	.	3208	3122	3220	3275	3274	3296	3424	3419	110.8	60.1
OLDS 98 FWD	1852	2103	2-DOOR	3213	3283	3190	.	.	.	.	.	.	110.8	60.1
OLDS 98 FWD	1852	2103	4-DOOR	3260	3317	3220	3323	3360	3366	3586	3598	3533	110.8	60.1
PONT BONNEVIL FWD	1852	2202	4-DOOR	.	.	3302	3308	3338	3363	3355	3473	3469	110.8	60.1
PONT FIERO	1853	2205	2-DOOR	2535	2617	2615	2685	.	.	.	.	.	93.4	58.3
BUICK SKYLARK N	1854	1818	2-DOOR	2561	2548	2544	2611	2627	2640	2628	2850	2803	103.4	55.4
BUICK SKYLARK N	1854	1818	4-DOOR	.	2589	2586	2661	2672	2625	2681	2895	2849	103.4	55.4
OLDS CALAIS	1854	2118	2-DOOR	2531	2519	2461	2512	2576	2616	2551	.	.	103.4	55.4
OLDS CALAIS	1854	2118	4-DOOR	.	2583	2525	2575	2621	2627	2639	.	.	103.4	55.4
OLDS ACHIEVA	1854	2121	2-DOOR	.	.	.	.	.	.	.	2719	2717	103.4	55.7
OLDS ACHIEVA	1854	2121	4-DOOR	.	.	.	.	.	.	.	2805	2779	103.4	55.7
PONT GRAND AM	1854	2218	2-DOOR	2517	2540	2513	2559	2557	2588	2572	2751	2764	103.4	55.4
PONT GRAND AM	1854	2218	4-DOOR	.	2607	2587	2641	2609	2640	2654	2794	2804	103.4	55.4
BUICK RIVIERA 86-	1855	1805	2-DOOR	.	3323	3311	3365	3424	3464	3496	3498	3504	108.0	59.9
CADI ELDORADO 86-	1855	1905	2-DOOR	.	3365	3387	3394	3426	3426	3458	3569	3604	108.0	59.9
CADI SEVILLE 86-91	1855	1914	4-DOOR	.	3426	3456	3449	3557	3557	3514	.	.	108.0	59.9
OLDS TORONADO 86-	1855	2105	2-DOOR	.	3304	3260	3397	3403	3522	3503	3517	.	108.0	59.9
CHEV CORSCA/BERTTA	1856	2019	2-DOOR	.	.	2606	2673	2701	2763	2735	2796	2769	103.4	55.4
CHEV CORSCA/BERTTA	1856	2019	4-DOOR	.	.	2518	2639	2648	2709	2701	2752	2745	103.4	55.4
CADI ALLANTE	1857	1909	CONVRTBL	.	.	3494	3492	3462	3462	3480	3498	3752	99.4	60.5
BUICK REATTA	1858	1821	CONVRTBL	.	.	.	.	.	3569	3596	.	.	98.5	60.3
BUICK REATTA	1858	1821	2-DOOR	.	.	.	3356	3382	3372	3391	.	.	98.5	60.3
BUICK REGAL FWD	1859	1820	2-DOOR	.	.	.	2952	3154	3250	3296	3265	3293	107.5	58.8
BUICK REGAL FWD	1859	1820	4-DOOR	.	.	.	.	.	.	3366	3335	3361	107.5	58.8
CHEV LUMINA	1859	2020	2-DOOR	.	.	.	.	.	3197	3242	3289	3364	107.5	58.8
CHEV LUMINA	1859	2020	4-DOOR	.	.	.	.	.	3256	3275	3310	3280	107.5	58.8
OLDS SUPREME FWD	1859	2120	CONVRTBL	.	.	.	.	.	3485	3602	3589	3711	107.5	58.8
OLDS SUPREME FWD	1859	2120	2-DOOR	.	.	.	2958	3153	3227	3236	3248	3253	107.5	58.8
OLDS SUPREME FWD	1859	2120	4-DOOR	.	.	.	.	.	3345	3368	3382	3358	107.5	58.8
PONT GRN PRIX FWD	1859	2220	2-DOOR	.	.	.	3061	3129	3290	3256	3204	3215	107.5	58.8
PONT GRN PRIX FWD	1859	2220	4-DOOR	.	.	.	.	.	3374	3291	3308	3319	107.5	58.8
CADI DEVILLE 90-	1860	1903	4-DOOR	.	.	.	.	.	3553	3597	3594	3607	113.8	60.1
SATURN 2DR	1861	2402	2-DOOR	.	.	.	.	.	.	2375	2256	2372	99.2	56.4
SATURN 4DR	1862	2401	4-DOOR	.	.	.	.	.	.	2315	2335	2373	102.4	56.4
SATURN SW	1862	2403	STA WAGN	.	.	.	.	.	.	.	.	2427	102.4	56.4
CADI SEVILLE 92-	1863	1914	4-DOOR	.	.	.	.	.	.	.	3661	3687	111.0	60.9
VW SCIROCCO	3004	3038	2-DOOR	2181	2221	2270	2287	.	.	.	.	.	94.5	54.1
VW CABRIOLET	3004	3042	CONVRTBL	2254	2254	2254	2274	2274	2274	2307	2307	2350	94.5	54.1
VW QUANTUM	3005	3041	4-DOOR	2658	2661	2661	2646	.	.	.	.	.	100.4	55.9
VW QUANTUM	3005	3041	STA WAGN	2555	2694	2846	2888	.	.	.	.	.	100.4	55.9
VW JETTA	3006	3040	2-DOOR	2273	2273	2252	2305	2311	2312	2297	.	2665	97.3	56.2
VW JETTA	3006	3040	4-DOOR	2326	2348	2335	2345	2360	2336	2424	2340	2735	97.3	56.2
VW GOLF/GTI	3006	3042	2-DOOR	2168	2164	2211	2182	2212	2248	2352	2339	.	97.3	56.2
VW GOLF/GTI	3006	3042	4-DOOR	2194	2195	2310	2209	2246	2246	2375	2375	2665	97.3	56.2
VW CORRADO	3006	3045	2-DOOR	.	.	.	.	.	2660	2558	2797	2810	97.3	56.4
VW FOX	3007	3044	2-DOOR	.	.	2150	2126	2126	2126	2172	2172	2172	92.8	53.5
VW FOX	3007	3044	4-DOOR	.	.	2190	2190	2203	2203	2238	2238	2238	92.8	53.5
VW FOX	3007	3044	STA WAGN	.	.	2190	2190	2214	2214	.	.	.	92.8	53.5
VW PASSAT	3008	3046	4-DOOR	.	.	.	.	.	2990	2985	2985	3134	103.3	57.1

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
VW PASSAT	3008	3046	STA WAGN	.	.	.	.	.	3035	3029	3029	3197	103.3	57.1
AUDI 4000	3204	3234	2-DOOR	2694	2688	2663	.	.	.	.	.	.	99.8	55.5
AUDI 4000	3204	3234	4-DOOR	2337	2377	2337	.	.	.	.	.	.	99.8	55.5
AUDI 5000	3205	3235	4-DOOR	2894	2913	2952	2986	.	.	.	.	.	105.8	57.8
AUDI 100/200	3205	3237	4-DOOR	.	.	.	.	3146	3297	3275	3435	3516	106.0	60.1
AUDI 100/200	3205	3237	STA WAGN	.	.	.	.	3314	3572	3726	3892	3892	106.0	60.1
AUDI 80/90 88-92	3206	3236	4-DOOR	.	.	.	2720	2715	2816	2994	2939	.	100.2	56.0
AUDI 90 1993	3207	3236	4-DOOR	.	.	.	.	.	.	.	.	3287	102.8	57.6
BMW 500 -88	3406	3435	4-DOOR	3159	3171	3177	3159	.	.	.	.	.	103.3	57.1
BMW 300	3407	3434	CONVRTBL	.	.	3035	3055	3035	2990	2921	2944	.	101.2	55.6
BMW 300	3407	3434	2-DOOR	2581	2722	2770	2837	2820	2817	2683	2866	.	101.2	55.6
BMW 300	3407	3434	4-DOOR	2609	2789	2802	2875	2884	2867	2700	.	.	101.2	55.6
BMW 600	3408	3436	2-DOOR	3406	3407	3416	3516	3530	.	.	.	.	103.5	57.1
BMW 700 -86	3409	3437	4-DOOR	3556	3565	.	.	.	.	.	.	.	110.0	59.4
BMW 700 87-	3410	3437	4-DOOR	.	.	3836	3835	3835	3880	3793	3795	4001	111.5	60.6
BMW 700L 87-	3411	3437	4-DOOR	.	.	.	4079	4140	4127	4059	4012	4093	116.0	60.6
BMW 500 89-	3412	3435	4-DOOR	.	.	.	.	3452	3486	3525	3521	3521	108.7	58.4
BMW 850	3413	3438	2-DOOR	.	.	.	.	.	.	4123	4123	4123	105.7	61.3
BMW 300 92-	3414	3434	CONVRTBL	.	.	.	.	.	.	.	2990	2988	106.3	55.7
BMW 300 92-	3414	3434	2-DOOR	.	.	.	.	.	.	.	3020	3018	106.3	55.7
BMW 300 92-	3414	3434	4-DOOR	.	.	.	.	.	.	.	3003	3041	106.3	55.7
NISS 300ZX -88	3514	3534	2-DOOR	3100	3154	3162	3164	.	.	.	.	.	91.3	57.7
NISS 300ZX 2+2 -89	3515	3534	2-DOOR	3139	3232	3265	3265	3187	.	.	.	.	99.2	57.7
NISS SENTRA -86	3518	3543	2-DOOR	1905	1876	.	.	.	.	.	.	.	94.5	54.7
NISS SENTRA -86	3518	3543	4-DOOR	1855	1938	.	.	.	.	.	.	.	94.5	54.7
NISS SENTRA -86	3518	3543	STA WAGN	1955	2024	.	.	.	.	.	.	.	94.5	54.7
NISS STANZA -86	3519	3542	4-DOOR	2301	2325	.	.	.	.	.	.	.	97.2	55.9
NISS PULSAR -86	3520	3544	2-DOOR	1907	2008	.	.	.	.	.	.	.	95.1	54.1
NISS 200SX -88	3521	3532	2-DOOR	2476	2615	2714	2604	.	.	.	.	.	95.5	55.1
NISS MAXIMA -88	3522	3539	4-DOOR	3060	3060	3040	3120	.	.	.	.	.	100.4	57.3
NISS MAXIMA -88	3522	3539	STA WAGN	3296	3210	3280	3330	.	.	.	.	.	100.4	57.3
NISS STANZA 87-92	3522	3542	4-DOOR	.	.	2774	2770	2770	2788	2788	2788	.	100.4	57.1
INFINITI G20	3522	5833	4-DOOR	.	.	.	.	.	.	2647	2789	2745	100.4	57.6
NISS STANZA SW -89	3523	3542	STA WAGN	.	2809	2893	2805	2805	.	.	.	.	99.0	55.9
NISS SENTRA 87-	3524	3543	2-DOOR	.	.	2216	2173	2163	2158	2286	2280	2334	95.7	56.6
NISS SENTRA 87-	3524	3543	4-DOOR	.	.	2231	2208	2208	2208	2266	2288	2365	95.7	56.6
NISS SENTRA 87-	3524	3543	STA WAGN	.	.	2339	2355	2301	2301	.	.	.	95.7	56.6
NISS PULSAR 87-90	3524	3544	2-DOOR	.	.	2400	2388	2397	2388	.	.	.	95.7	56.9
NISS NX	3524	3546	2-DOOR	.	.	.	.	.	.	2447	2401	2402	95.7	56.2
NISS MAXIMA 89-	3525	3539	4-DOOR	.	.	.	.	3086	3086	3029	3135	3144	104.3	59.1
NISS 240SX 89-	3526	3532	CONVRTBL	.	.	.	.	.	.	.	3093	3093	97.4	57.6
NISS 240SX 89-	3526	3532	2-DOOR	.	.	.	.	2674	2680	2732	2731	2718	97.4	57.6
NISS 300ZX 90-	3527	3534	2-DOOR	.	.	.	.	.	3286	3338	3273	3186	96.5	59.6
NISS 300ZX 2+2 90-	3528	3534	2-DOOR	.	.	.	.	.	3313	3313	3313	3313	101.2	59.6
INFINITI M30	3529	5831	CONVRTBL	.	.	.	.	.	.	3576	3576	.	103.0	56.5
INFINITI M30	3529	5831	2-DOOR	.	.	.	.	.	3333	3333	3333	.	103.0	56.5
INFINITI Q45	3530	5832	4-DOOR	.	.	.	.	.	3950	3950	3957	3957	113.2	61.8
NISS AXXESS	3531	3548	STA WAGN	.	.	.	.	.	2967	2937	.	.	102.8	56.9
NISS ALTIMA	3532	3547	4-DOOR	.	.	.	.	.	.	.	.	2829	103.1	57.5

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
INFINITI J30	3533	5834	4-DOOR	.	.	.	.	.	.	.	.	3527	108.7	59.1
HOND CIVIC 4DR -87	3707	3731	4-DOOR	1939	2034	1992	.	.	.	.	.	.	96.5	55.4
HOND CIVIC 4DR -87	3707	3731	STA WAGN	2064	2148	2166	.	.	.	.	.	.	96.5	55.4
HOND ACCORD 1985	3707	3732	2-DOOR	2177	.	.	.	.	.	.	.	.	96.5	56.4
HOND ACCORD 1985	3707	3732	4-DOOR	2258	.	.	.	.	.	.	.	.	96.5	56.4
HOND PRELUDE -87	3707	3733	2-DOOR	2277	2345	2291	.	.	.	.	.	.	96.5	57.9
ACUR INTGR 2DR -89	3707	5431	2-DOOR	.	2270	2349	2347	2313	.	.	.	.	96.5	56.2
HOND CRX -87	3708	3735	2-DOOR	1771	1848	1813	.	.	.	.	.	.	86.6	53.6
HOND CIVIC 2DR -87	3709	3731	2-DOOR	1855	1937	1895	.	.	.	.	.	.	93.7	55.4
HOND ACCORD 86-89	3710	3732	2-DOOR	.	2456	2429	2495	2583	.	.	.	.	102.4	58.2
HOND ACCORD 86-89	3710	3732	4-DOOR	.	2491	2479	2549	2575	.	.	.	.	102.4	58.2
ACUR INTGR 4DR 90-	3710	5431	4-DOOR	.	.	.	.	.	2604	2680	2667	2665	102.4	58.1
ACUR LEGND 4DR -90	3711	5432	4-DOOR	.	3077	3082	3100	3170	3142	.	.	.	108.6	58.3
STERLING	3711	6131	4-DOOR	.	.	3246	3244	3177	3230	3187	.	.	108.6	57.4
ACUR INTGR 4DR -89	3712	5431	4-DOOR	.	2329	2409	2394	2390	.	.	.	.	99.2	56.2
ACUR LEGND 2DR -90	3713	5432	2-DOOR	.	.	3119	3100	3139	3153	.	.	.	106.5	59.1
HOND CRX 88-92	3714	3735	2-DOOR	.	.	.	1930	2054	2129	2097	.	.	90.6	57.1
HOND CIVIC 88-91	3715	3731	2-DOOR	.	.	.	2045	2073	2170	2164	.	.	98.4	57.1
HOND CIVIC 88-91	3715	3731	4-DOOR	.	.	.	2039	2188	2311	2290	.	.	98.4	57.1
HOND CIVIC 88-91	3715	3731	STA WAGN	.	.	.	2198	2298	2376	2412	.	.	98.4	57.1
HOND PRELUDE 88-91	3716	3733	2-DOOR	.	.	.	2622	2675	2664	2679	.	.	101.0	58.1
HOND PRELUDE 92-	3717	3733	2-DOOR	.	.	.	.	.	.	.	2841	2868	100.4	59.8
ACUR INTGR 2DR 90-	3717	5431	2-DOOR	.	.	.	.	.	2566	2617	2616	2615	100.4	58.1
HOND ACCORD 90-	3718	3732	2-DOOR	.	.	.	.	.	2840	2841	2874	2913	107.1	58.2
HOND ACCORD 90-	3718	3732	4-DOOR	.	.	.	.	.	2870	2869	2901	2929	107.1	58.2
HOND ACCORD 90-	3718	3732	STA WAGN	.	.	.	.	.	.	2939	2984	3162	107.1	58.2
ACUR NSX	3719	5433	2-DOOR	.	.	.	.	.	.	3010	3009	3020	99.6	59.8
ACUR LEGND 2DR 91-	3720	5432	2-DOOR	.	.	.	.	.	.	3408	3436	3439	114.0	60.8
ACUR LEGND 4DR 91-	3721	5432	4-DOOR	.	.	.	.	.	.	3455	3464	3516	114.6	60.8
HOND CIVIC 2DR 92-	3722	3731	2-DOOR	.	.	.	.	.	.	.	2157	2228	101.3	57.9
HOND CIVIC 4DR 92-	3723	3731	4-DOOR	.	.	.	.	.	.	.	2318	2333	103.2	57.9
ACUR VIGOR	3724	5434	4-DOOR	.	.	.	.	.	.	.	3200	3201	110.5	59.6
HOND CIVIC DEL SOL	3725	3735	2-DOOR	.	.	.	.	.	.	.	.	2350	93.3	57.9
ISUZU I-MARK 1985	3801	3831	2-DOOR	1919	.	.	.	.	.	.	.	.	94.3	51.4
ISUZU I-MARK 1985	3801	3831	4-DOOR	2001	.	.	.	.	.	.	.	.	94.3	51.4
ISUZU IMPULSE -89	3802	3832	2-DOOR	2734	2755	2895	2911	2926	.	.	.	.	96.1	53.5
CHEV SPECTRUM	3803	2031	2-DOOR	1808	1808	1962	1968	1962	.	.	.	.	94.5	54.5
CHEV SPECTRUM	3803	2031	4-DOOR	1859	1909	2007	1995	1989	.	.	.	.	94.5	54.5
ISUZU I-MARK 86-	3803	3831	2-DOOR	.	1919	2028	2036	1996	.	.	.	.	94.5	54.5
ISUZU I-MARK 86-	3803	3831	4-DOOR	.	1933	2029	2028	2049	.	.	.	.	94.5	54.5
GEO STORM	3804	2035	2-DOOR	.	.	.	.	.	2304	2315	2302	2304	96.5	55.8
ISUZU IMPULSE 90-	3804	3832	2-DOOR	.	.	.	.	.	2411	2426	2645	2451	96.5	55.8
ISUZU STYLUS	3804	3833	4-DOOR	.	.	.	.	.	.	2302	2295	2253	96.5	55.8
JAGUAR XJ SEDAN	3903	3932	4-DOOR	4070	4068	4066	3903	3922	3960	3964	3990	4024	113.0	59.1
JAGUAR XJ-S COUPE	3904	3931	CONVRTBL	.	.	.	4250	4190	4190	4250	4250	3950	102.0	58.9
JAGUAR XJ-S COUPE	3904	3931	2-DOOR	3950	3956	3994	4040	4015	4015	4050	4050	3725	102.0	58.9
MAZDA RX-7 1985	4107	4134	2-DOOR	2382	.	.	.	.	.	.	.	.	95.3	55.5
MAZDA GLC	4109	4135	2-DOOR	1890	.	.	.	.	.	.	.	.	93.1	54.8

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
MAZDA GLC	4109	4135	4-DOOR	1935	1935	.	.	.	.	.	.	.	93.1	54.8
MAZDA GLC	4109	4135	STA WAGN	2130	2130	.	.	.	.	.	.	.	93.1	54.8
MAZDA 626 -87	4110	4137	2-DOOR	2385	2405	2474	.	.	.	.	.	.	98.8	56.2
MAZDA 626 -87	4110	4137	4-DOOR	2422	2431	2462	.	.	.	.	.	.	98.8	56.2
MERC TRACER -90	4111	1436	2-DOOR	.	.	.	2158	2205	.	.	.	.	94.7	55.5
MERC TRACER -90	4111	1436	4-DOOR	.	.	.	2185	2240	.	.	.	.	94.7	55.5
MERC TRACER -90	4111	1436	STA WAGN	.	.	.	2233	2335	.	.	.	.	94.7	55.5
MAZDA 323 -89	4111	4135	2-DOOR	.	2060	2060	2116	2101	.	.	.	.	94.5	55.2
MAZDA 323 -89	4111	4135	4-DOOR	.	2115	2115	2155	2175	.	.	.	.	94.5	55.2
MAZDA 323 -89	4111	4135	STA WAGN	.	.	2170	2230	.	.	.	.	.	94.5	55.2
MAZDA RX-7 86-91	4112	4134	CONVRTBL	.	.	.	3003	3003	3045	3071	.	.	95.7	56.9
MAZDA RX-7 86-91	4112	4134	2-DOOR	.	2625	2663	2656	2806	2890	2795	.	.	95.7	56.9
MAZDA 626 88-92	4113	4137	4-DOOR	.	.	.	2608	2678	2624	2692	2610	.	101.4	57.5
MAZDA 929 -91	4114	4143	4-DOOR	.	.	.	3282	3373	3477	3554	.	.	106.7	57.2
FORD PROBE -92	4115	1218	2-DOOR	.	.	.	.	2739	2849	2890	2811	.	99.0	57.5
MAZDA MX-6 -92	4115	4144	2-DOOR	.	.	.	2535	2572	2585	2746	2564	.	99.0	57.5
MAZDA 323 2DR 90-	4116	4135	2-DOOR	.	.	.	.	.	2238	2238	2238	2238	96.5	56.5
FORD ESCORT 90-	4117	1213	2-DOOR	.	.	.	.	.	.	2350	2350	2335	98.4	56.5
FORD ESCORT 90-	4117	1213	4-DOOR	.	.	.	.	.	.	2355	2368	2358	98.4	56.5
FORD ESCORT 90-	4117	1213	STA WAGN	.	.	.	.	.	.	2411	2411	2403	98.4	56.5
MERC TRACER 91-	4117	1436	4-DOOR	.	.	.	.	.	.	2376	2368	2358	98.4	56.5
MERC TRACER 91-	4117	1436	STA WAGN	.	.	.	.	.	.	2468	2468	2462	98.4	56.5
MAZDA PROTEGE	4117	4135	4-DOOR	.	.	.	.	.	2408	2405	2423	2415	98.4	56.4
MAZDA MIATA	4118	4145	CONVRTBL	.	.	.	.	.	2182	2182	2216	2216	89.2	55.9
MAZDA MX-3	4119	4146	2-DOOR	.	.	.	.	.	.	.	2410	2378	96.3	57.6
MAZDA 929 92-	4120	4143	4-DOOR	.	.	.	.	.	.	.	3596	3596	112.2	59.6
FORD PROBE 1993	4121	1218	2-DOOR	.	.	.	.	.	.	.	.	2712	102.9	59.4
MAZDA 626 1993	4121	4137	4-DOOR	.	.	.	.	.	.	.	.	2627	102.9	59.1
MAZDA MX-6 1993	4121	4144	2-DOOR	.	.	.	.	.	.	.	.	2658	102.9	59.1
MAZDA RX-7 1993	4122	4134	CONVRTBL	.	.	.	.	.	.	.	.	2789	95.5	57.5
MAZDA RX-7 1993	4122	4134	2-DOOR	.	.	.	.	.	.	.	.	2789	95.5	57.5
ME-BE 380SL 1985	4204	4233	2-DOOR	3640	.	.	.	.	.	.	.	.	96.9	57.0
ME-BE BASIC 4DR 85	4208	4231	4-DOOR	3585	.	.	.	.	.	.	.	.	110.0	57.8
ME-BE BASIC 4DR 85	4208	4231	STA WAGN	3780	.	.	.	.	.	.	.	.	110.0	57.8
ME-BE BASIC 2DR 85	4209	4231	2-DOOR	3585	.	.	.	.	.	.	.	.	106.7	57.8
ME-BE S 4DR -91	4210	4237	4-DOOR	3729	.	.	3730	3730	3740	3761	.	.	115.6	60.7
ME-BE SEL 4DR -91	4211	4236	4-DOOR	3780	3928	3886	3911	3924	3930	3951	.	.	121.1	60.7
ME-BE SEC 2DR -91	4212	4236	2-DOOR	3760	3960	3890	3915	3915	3915	3915	.	.	112.2	60.7
ME-BE 190	4213	4239	4-DOOR	2654	2988	2816	2802	2955	2955	2958	2969	2983	104.9	56.0
ME-BE BAS 4DR 86-	4214	4231	4-DOOR	.	3295	3262	3189	3252	3319	3377	3477	3544	110.2	58.8
ME-BE BAS 4DR 86-	4214	4231	STA WAGN	.	.	3670	3475	3530	3646	3721	3695	3788	110.2	58.8
ME-BE SL 86-89	4215	4233	2-DOOR	.	3780	3705	3705	3705	.	.	.	.	96.7	57.7
ME-BE BAS 2DR 88-	4216	4231	2-DOOR	.	.	.	3310	3310	3505	3505	3505	3525	106.9	58.9
ME-BE SL 90-	4217	4233	2-DOOR	.	.	.	.	.	4058	4091	4267	4205	99.0	60.2
ME-BE SEC 2DR 92-	4218	4236	2-DOOR	.	.	.	.	.	.	.	.	4936	119.7	62.6
ME-BE S 4DR 92-	4218	4237	4-DOOR	.	.	.	.	.	.	.	4609	4627	119.7	62.6
ME-BE SEL 4DR 92-	4219	4236	4-DOOR	.	.	.	.	.	.	.	4783	4802	123.6	62.6
PEUGEOT 505 4DR	4406	4434	4-DOOR	3102	3059	3081	3053	3092	.	.	.	.	107.9	57.0
PEUGEOT 505 SW	4407	4434	STA WAGN	3257	3149	3289	3120	3328	.	3339	.	.	114.2	58.2
PEUGEOT 405	4408	4436	4-DOOR	.	.	.	.	2577	2643	2600	.	.	105.1	57.0

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
PEUGEOT 405	4408	4436	STA WAGN	.	.	.	.	.	2726	2688	.	.	105.1	57.0
PORSCHE 911	4501	4531	CONVRTBL	2756	2756	2756	2784	2785	3031	3031	.	.	89.5	54.1
PORSCHE 911	4501	4531	2-DOOR	2756	2826	2828	2802	2974	3031	3100	.	.	89.5	54.1
PORSCHE 924	4503	4534	2-DOOR	.	.	2734	2734	.	.	.	.	.	94.5	55.3
PORSCHE 944	4503	4537	CONVRTBL	.	.	.	.	2932	3109	3109	.	.	94.5	57.7
PORSCHE 944	4503	4537	2-DOOR	2778	2827	2842	2896	2909	2998	2998	.	.	94.5	57.7
PORSCHE 928	4504	4535	2-DOOR	3366	3439	3505	3505	3505	3505	3505	.	.	98.4	61.5
PORSCHE 1992-93	4505	4540	CONVRTBL	.	.	.	.	.	.	.	3112	3225	.	.
PORSCHE 1992-93	4505	4540	2-DOOR	.	.	.	.	.	.	.	3053	3108	.	.
RENA 18/SPORTWAGON	4605	4637	STA WAGN	2405	2405	.	.	.	.	.	.	.	96.1	54.6
RENA FUEGO	4605	4638	2-DOOR	2379	.	.	.	.	.	.	.	.	96.1	54.7
RENA ALLIANCE	4606	4639	CONVRTBL	2250	2261	2277	.	.	.	.	.	.	97.8	54.0
RENA ALLIANCE	4606	4639	2-DOOR	1983	1977	2034	.	.	.	.	.	.	97.8	54.0
RENA ALLIANCE	4606	4639	4-DOOR	2041	2034	2037	.	.	.	.	.	.	97.8	54.0
RENA ENCORE	4606	4640	2-DOOR	2013	2031	.	.	.	.	.	.	.	97.8	54.0
RENA ENCORE	4606	4640	4-DOOR	2082	2076	.	.	.	.	.	.	.	97.8	54.0
RENA MEDALLION 4DR	4607	4644	4-DOOR	.	.	.	2588	2650	.	.	.	.	102.3	56.3
RENA MEDALLION SW	4608	4644	STA WAGN	.	.	.	2736	2809	.	.	.	.	108.3	56.3
DODGE MONACO	4609	740	4-DOOR	.	.	.	.	.	3103	3013	3004	.	106.0	57.6
EAGLE PREMIER	4609	1040	4-DOOR	.	.	.	2918	3039	3087	3079	3059	.	106.0	57.6
SAAB 900	4704	4731	CONVRTBL	.	3120	2920	2875	2967	2967	3003	3001	3011	99.1	56.5
SAAB 900	4704	4731	2-DOOR	2732	2737	2822	2818	2792	2808	2835	2767	2789	99.1	56.5
SAAB 900	4704	4731	4-DOOR	2730	2691	2798	2770	2809	2815	2818	2776	2810	99.1	56.5
SAAB 9000	4705	4734	4-DOOR	.	2935	3018	3022	3105	3087	3105	3150	3128	105.2	59.3
SUBA SEDAN/LOYALE	4806	4831	2-DOOR	.	2322	2350	2352	2352	2385	.	.	.	97.2	56.1
SUBA SEDAN/LOYALE	4806	4831	4-DOOR	2272	2286	2323	2278	2294	2283	2388	2374	2371	97.2	56.1
SUBA SEDAN/LOYALE	4806	4831	STA WAGN	2429	2594	2537	2528	2542	2535	2602	2596	2593	97.2	56.1
SUBA XT	4806	4835	2-DOOR	2443	2394	2477	2644	2534	2586	2761	.	.	97.1	56.3
SUBA HATCHBACK -89	4807	4831	2-DOOR	2132	2099	2197	2174	2174	.	.	.	.	93.5	53.0
SUBA JUSTY	4808	4836	2-DOOR	.	.	1666	1655	1807	1906	1895	1851	1857	90.0	51.6
SUBA JUSTY	4808	4836	4-DOOR	.	.	.	.	.	2045	2045	2045	2045	90.0	51.6
SUBA LEGACY	4809	4834	4-DOOR	.	.	.	.	.	2723	2846	2936	2950	101.6	57.4
SUBA LEGACY	4809	4834	STA WAGN	.	.	.	.	.	2891	2964	2933	3011	101.6	57.4
SUBA SVX	4810	4837	2-DOOR	.	.	.	.	.	.	.	3575	3580	102.8	58.7
SUBA IMPREZA	4811	4838	4-DOOR	.	.	.	.	.	.	.	.	2384	99.2	57.4
SUBA IMPREZA	4811	4838	STA WAGN	.	.	.	.	.	.	.	.	2551	99.2	57.4
TOYO CELICA -86	4911	4933	CONVRTBL	2975	.	.	.	.	.	.	.	.	98.4	54.3
TOYO CELICA -86	4911	4933	2-DOOR	2585	2540	.	.	.	.	.	.	.	98.4	54.3
TOYO CRESSIDA 1985	4912	4935	4-DOOR	3020	.	.	.	.	.	.	.	.	104.1	54.8
TOYO CRESSIDA 1985	4912	4935	STA WAGN	3007	.	.	.	.	.	.	.	.	104.1	54.8
TOYO COROLLA RWD	4916	4932	2-DOOR	2211	2250	2225	.	.	.	.	.	.	94.5	52.8
TOYO SUPRA 1985	4918	4934	2-DOOR	2970	2970	.	.	.	.	.	.	.	103.0	57.3
GEO NOVA/PRIZM -92	4919	2032	4-DOOR	2163	2174	2214	2219	2327	2331	2437	2436	.	95.7	55.7
TOYO CORLA FWD -92	4919	4932	2-DOOR	.	.	2353	2230	2276	2434	2296	.	.	95.7	55.7
TOYO CORLA FWD -92	4919	4932	4-DOOR	2113	2103	2139	2212	2235	2250	2257	2267	.	95.7	55.7
TOYO CORLA FWD -92	4919	4932	STA WAGN	.	.	.	2344	2694	2484	2355	2373	.	95.7	55.7
TOYO TERCEL 85-87	4919	4938	2-DOOR	1995	2025	.	.	.	.	.	.	.	95.7	54.2

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
TOYO TERCEL 85-87	4919	4938	4-DOOR	2037	2060	.	.	.	.	.	.	.	95.7	54.2
TOYO TERCEL 85-87	4919	4938	STA WAGN	2220	2139	2204	.	.	.	.	.	.	95.7	54.2
TOYO CAMRY -91	4920	4940	4-DOOR	2385	2406	2758	2761	2798	2746	2786	.	.	102.4	57.5
TOYO CAMRY -91	4920	4940	STA WAGN	.	.	2876	2877	2937	2982	2989	.	.	102.4	57.5
LEXUS ES-250	4920	5931	4-DOOR	.	.	.	.	.	3219	3219	.	.	102.4	57.5
TOYO MR-2 -89	4921	4941	2-DOOR	2459	2282	2334	2390	2375	.	.	.	.	91.3	56.7
TOYO CRESSIDA 86-	4922	4935	4-DOOR	.	3142	3296	3328	3417	3417	3439	3439	.	104.5	57.0
TOYO CRESSIDA 86-	4922	4935	STA WAGN	.	3097	3240	.	.	.	.	.	.	104.5	57.0
TOYO SUPRA 86-92	4923	4934	2-DOOR	.	3468	3451	3488	3492	3501	3512	3509	.	102.2	58.5
TOYO CELICA 87-	4924	4933	CONVRTBL	.	.	2700	2680	2680	2680	2844	2844	3020	99.4	57.2
TOYO CELICA 87-	4924	4933	2-DOOR	.	.	2527	2507	2480	2636	2610	2564	2772	99.4	57.2
TOYO TERCEL 87-	4925	4938	2-DOOR	.	.	1955	2022	1996	2012	1950	1957	1955	93.7	55.7
TOYO TERCEL 87-	4925	4938	4-DOOR	.	.	2075	2025	2025	.	2005	2005	2005	93.7	55.7
TOYO TERCEL 87-	4925	4938	STA WAGN	.	.	.	2280	.	.	.	.	.	93.7	55.7
TOYO PASEO	4925	4942	2-DOOR	.	.	.	.	.	.	.	2070	2070	93.7	55.1
LEXUS LS-400	4926	5932	4-DOOR	.	.	.	.	.	3759	3759	3759	3858	110.8	61.6
TOYO MR-2 91-	4927	4941	2-DOOR	.	.	.	.	.	.	2599	2639	2754	94.5	57.5
TOYO CAMRY 92-	4928	4940	4-DOOR	.	.	.	.	.	.	.	3133	3076	103.1	60.0
TOYO CAMRY 92-	4928	4940	STA WAGN	.	.	.	.	.	.	.	3117	3218	103.1	60.0
LEXUS ES-300	4928	5931	4-DOOR	.	.	.	.	.	.	.	3406	3362	103.1	60.0
LEXUS SC-300/400	4929	5933	2-DOOR	.	.	.	.	.	.	.	3556	3548	105.9	59.9
GEO PRIZM 1993	4930	2032	4-DOOR	.	.	.	.	.	.	.	.	2350	97.0	57.0
TOYO COROLLA 1993	4930	4932	4-DOOR	.	.	.	.	.	.	.	.	2443	97.0	57.3
TOYO COROLLA 1993	4930	4932	STA WAGN	.	.	.	.	.	.	.	.	2392	97.0	57.3
TOYO SUPRA 1993	4931	4934	2-DOOR	.	.	.	.	.	.	.	.	3389	100.4	60.0
LEXUS GS-300	4932	5934	4-DOOR	.	.	.	.	.	.	.	.	3625	109.4	60.2
VOLVO 240	5104	5134	4-DOOR	2904	2919	2950	2928	2919	2954	2919	2954	2919	104.3	54.9
VOLVO 240	5104	5134	STA WAGN	3002	3075	3034	3047	3051	3084	3051	3084	3054	104.3	54.9
VOLVO 760/780	5105	5138	2-DOOR	.	.	3329	3411	3433	3415	3415	.	.	109.1	57.5
VOLVO 760/780	5105	5138	4-DOOR	2994	3031	3095	3319	3305	3304	.	.	.	109.1	57.5
VOLVO 760/780	5105	5138	STA WAGN	3209	3185	3226	3305	3272	3272	.	.	.	109.1	57.5
VOLVO 740	5105	5139	4-DOOR	.	2971	2957	2959	2982	3010	2976	2996	.	109.1	57.7
VOLVO 740	5105	5139	STA WAGN	3128	3094	3101	3107	3120	3118	3077	3155	.	109.1	57.7
VOLVO 940	5105	5140	4-DOOR	.	.	.	.	.	.	3120	3041	3067	109.1	57.7
VOLVO 940	5105	5140	STA WAGN	.	.	.	.	.	.	3140	3194	3177	109.1	57.7
VOLVO 960	5105	5141	4-DOOR	.	.	.	.	.	.	.	3460	3460	109.1	57.7
VOLVO 960	5105	5141	STA WAGN	.	.	.	.	.	.	.	3370	3370	109.1	57.7
VOLVO 850	5106	5142	4-DOOR	.	.	.	.	.	.	.	.	3187	104.9	58.9
DODGE COLT 2DR 85	5204	734	2-DOOR	1883	.	.	.	.	.	.	.	.	90.6	53.5
PLYM COLT 2DR 1985	5204	934	2-DOOR	1876	.	.	.	.	.	.	.	.	90.6	53.5
DODGE COLT 85-89	5205	734	2-DOOR	.	1882	1924	1988	.	.	.	.	.	93.7	53.7
DODGE COLT 85-89	5205	734	4-DOOR	1999	2002	2000	2085	.	.	.	.	.	93.7	53.7
DODGE COLT 85-89	5205	734	STA WAGN	.	.	.	2227	2359	2331	.	.	.	93.7	53.7
PLYM COLT 85-89	5205	934	2-DOOR	.	1882	1923	1990	.	.	.	.	.	93.7	53.7
PLYM COLT 85-89	5205	934	4-DOOR	2001	2013	1999	2098	.	.	.	.	.	93.7	53.7
PLYM COLT 85-89	5205	934	STA WAGN	.	.	.	2227	2358	2331	.	.	.	93.7	53.7
MITS MIRAGE -88	5205	5235	2-DOOR	1967	1964	2043	2171	.	.	.	.	.	93.7	53.8
MITS MIRAGE -88	5205	5235	4-DOOR	.	2095	2119	2271	.	.	.	.	.	93.7	53.8
MITS PRECIS -89	5205	5236	2-DOOR	.	.	2094	2176	2173	.	.	.	.	93.7	53.5
MITS PRECIS -89	5205	5236	4-DOOR	.	.	2137	2216	2216	.	.	.	.	93.7	53.5

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
HYUNDAI EXCEL -89	5205	5532	2-DOOR	.	2141	2141	2156	2140	.	.	.	.	93.7	53.5
HYUNDAI EXCEL -89	5205	5532	4-DOOR	.	2155	2160	2156	2163	.	.	.	.	93.7	53.5
CHRY CONQUEST	5206	635	2-DOOR	.	.	2953	2925	3031	.	.	.	.	95.9	57.5
DODGE CONQUEST	5206	735	2-DOOR	2811	2811	.	.	.	.	.	.	.	95.9	55.3
PLYM CONQUEST	5206	935	2-DOOR	2818	2812	.	.	.	.	.	.	.	95.9	55.3
MITS STARION	5206	5231	2-DOOR	2802	2802	2988	2970	3036	.	.	.	.	95.9	55.3
MITS TREDIA	5207	5232	4-DOOR	2368	2376	2375	.	.	.	.	.	.	96.3	54.8
MITS CORDIA	5207	5233	2-DOOR	2342	2364	2369	2396	.	.	.	.	.	96.3	54.8
DODGE VISTA -91	5208	744	STA WAGN	2537	2661	2661	2717	2742	2795	2802	.	.	103.3	54.8
PLYM VISTA -91	5208	944	STA WAGN	2536	2608	2665	2721	2743	2778	2808	.	.	103.3	54.8
MITS GALANT	5209	5234	4-DOOR	2778	2844	2811	3042	2601	2661	2749	2726	2733	102.4	57.0
MITS SIGMA	5209	5238	4-DOOR	.	.	.	.	3075	3108	.	.	.	102.4	56.3
EAGL SUMMT 4DR -92	5210	1034	2-DOOR	.	.	.	.	.	.	2261	.	.	96.7	56.3
EAGL SUMMT 4DR -92	5210	1034	4-DOOR	.	.	.	.	2347	2283	2277	2278	.	96.7	56.3
MITS MIRAG 4DR -92	5210	5235	2-DOOR	.	.	.	.	2280	.	.	.	.	96.7	56.3
MITS MIRAG 4DR -92	5210	5235	4-DOOR	.	.	.	.	2326	2277	2271	2272	.	96.7	56.3
DODGE COLT 89-92	5211	734	2-DOOR	.	.	.	.	2203	2194	2262	2232	.	93.9	56.3
PLYM COLT 89-92	5211	934	2-DOOR	.	.	.	.	2203	2194	2262	2267	.	93.9	56.3
EAGL SUMMT 2DR -92	5211	1034	2-DOOR	.	.	.	.	.	.	.	2221	.	93.9	56.3
MITS MIRAG 2DR -92	5211	5235	2-DOOR	.	.	.	.	.	2234	2205	2205	.	93.9	56.3
PLYM LASER	5212	937	2-DOOR	.	.	.	.	.	2644	2659	2602	2612	97.2	57.4
EAGLE TALON	5212	1037	2-DOOR	.	.	.	.	.	2908	2877	2855	2729	97.2	57.4
MITS ECLIPSE	5212	5237	2-DOOR	.	.	.	.	.	2671	2651	2610	2600	97.2	57.4
DODGE STEALTH	5213	739	2-DOOR	.	.	.	.	.	.	3274	3400	3211	97.2	61.8
MITS 3000GT	5213	5239	2-DOOR	.	.	.	.	.	.	3501	3487	3348	97.2	61.8
DODGE VISTA 92-	5214	744	STA WAGN	.	.	.	.	.	.	.	2823	2793	99.2	57.5
PLYM VISTA 92-	5214	944	STA WAGN	.	.	.	.	.	.	.	2823	2793	99.2	57.5
EAGLE SUMMIT SW	5214	1044	STA WAGN	.	.	.	.	.	.	.	2796	2810	99.2	57.5
MITS EXPO LRV	5214	5244	STA WAGN	.	.	.	.	.	.	.	2730	2725	99.2	57.5
MITS DIAMANTE	5215	5240	4-DOOR	.	.	.	.	.	.	.	3481	3448	107.1	60.3
MITS DIAMANTE	5215	5240	STA WAGN	.	.	.	.	.	.	.	.	3609	107.1	60.3
MITS EXPO SP	5215	5245	STA WAGN	.	.	.	.	.	.	.	2979	3021	107.1	57.5
DODGE COLT 2DR 93	5216	734	2-DOOR	.	.	.	.	.	.	.	.	2093	96.1	57.3
PLYM COLT 2DR 1993	5216	934	2-DOOR	.	.	.	.	.	.	.	.	2093	96.1	57.3
EAGL SUMMIT 2DR 93	5216	1034	2-DOOR	.	.	.	.	.	.	.	.	2094	96.1	57.3
MITS MIRAGE 2DR 93	5216	5235	2-DOOR	.	.	.	.	.	.	.	.	2101	96.1	57.3
DODGE COLT 4DR 93	5217	734	4-DOOR	.	.	.	.	.	.	.	.	2238	98.4	57.3
PLYM COLT 4DR 1993	5217	934	4-DOOR	.	.	.	.	.	.	.	.	2235	98.4	57.3
EAGL SUMMIT 4DR 93	5217	1034	4-DOOR	.	.	.	.	.	.	.	.	2241	98.4	57.3
MITS MIRAGE 4DR 93	5217	5235	4-DOOR	.	.	.	.	.	.	.	.	2212	98.4	57.3
CHEV SPRINT 2DR	5301	2033	2-DOOR	1488	1488	1574	1568	.	.	.	.	.	88.4	51.8
CHEV SPRINT 4DR	5302	2033	4-DOOR	.	1565	1620	1620	.	.	.	.	.	92.3	51.8
GEO METRO 2DR	5303	2034	CONVRTBL	.	.	.	.	.	1753	1753	1753	1650	89.2	53.3
GEO METRO 2DR	5303	2034	2-DOOR	.	.	.	.	1589	1619	1620	1646	1645	89.2	53.3
SUZUKI SWIFT 2DR	5303	5334	2-DOOR	.	.	.	.	1761	1727	1762	1766	1790	89.2	53.3
GEO METRO 4DR	5304	2034	4-DOOR	.	.	.	.	1640	1693	1693	1694	1650	93.1	53.3
SUZUKI SWIFT 4DR	5304	5334	4-DOOR	.	.	.	.	1741	1846	1848	1861	1900	93.1	53.3
HYUNDAI SONATA	5501	5533	4-DOOR	.	.	.	.	2722	2754	2756	2747	2751	104.3	57.9
MITS PRECIS 90-	5502	5236	2-DOOR	.	.	.	.	.	2336	2253	2145	2380	93.8	53.8
HYUNDAI EXCEL 90-	5502	5532	2-DOOR	.	.	.	.	.	2040	2202	2040	2152	93.8	53.8

Make-Model Name	CG	MM2	BODYTP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBAS	TRACK
HYUNDAI EXCEL 90-	5502	5532	4-DOOR	.	.	.	.	.	2040	2310	2215	2186	93.8	53.8
HYUNDAI SCOUPE	5502	5534	2-DOOR	.	.	.	.	.	.	2142	2147	2201	93.8	53.8
HYUNDAI ELANTRA	5503	5535	4-DOOR	.	.	.	.	.	.	.	2483	2482	98.4	56.3
MERKUR XR4TI	5603	5631	2-DOOR	2853	2915	2920	2920	2920	.	.	.	.	102.7	57.5
MERKUR SCORPIO	5604	5632	4-DOOR	.	.	.	3241	3241	.	.	.	.	108.7	58.1
YUGO	5701	5731	2-DOOR	.	1832	1832	1834	1832	1870	1870	.	.	84.7	51.6
DAIHATSU CHARADE	6001	6031	2-DOOR	.	.	.	1775	1836	1827	1852	1825	.	92.1	54.1
DAIHATSU CHARADE	6001	6031	4-DOOR	.	.	.	.	.	2047	2045	2061	.	92.1	54.1
PONT LEMANS 88-	6301	2231	2-DOOR	.	.	.	2180	2065	2138	2178	2175	2154	99.2	55.3
PONT LEMANS 88-	6301	2231	4-DOOR	.	.	.	2128	2124	2235	2246	2241	2203	99.2	55.3
FORD FESTIVA	6401	1234	2-DOOR	.	.	.	1725	1718	1715	1785	1834	1806	90.2	54.8
MERCURY CAPRI 89-	6501	1431	CONVRTBL	.	.	.	.	.	.	2402	2422	2409	94.7	55.5

APPENDIX E

CURB WEIGHT, TRACK WIDTH AND WHEELBASE OF LIGHT TRUCKS

CG	=	fundamental light-truck group (see Appendix C)
MM2	=	make-model code (see Appendix C)
TRKTYP	=	type of light truck
WT85	=	curb weight (pounds) in model year 1985. Source: Ward's Almanacs, edited for consistency from year to year and across related make-models
WHLBS	=	wheelbase for the basic or short-bed truck (inches). Source: Ward's Almanacs
WBLNG	=	wheelbase for the long-bed or extended truck (inches). Source: Ward's Almanacs
TRAK	=	track width (inches). Source: measurements at NHTSA's Vehicle Research and Test Center, and at other locations

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
JEEP J-10 LONG	7002	7002	LGE PICKUP	3724	3808	3790	3790	.	.	.	.	.	130.7	.	.
JEEP J-20	7002	7003	LGE PICKUP	4335	4388	4386	4386	.	.	.	.	.	130.7	.	.
JEEP CJ-8 SCRAMBLR	7003	7004	SML SUV	2684	2684	.	.	.	.	.	.	.	103.4	.	.
JEEP CJ-7	7004	7005	SML SUV	2603	2602	.	.	.	.	.	.	.	93.4	.	.
JEEP CHEROKEE	7005	7006	SML SUV	2751	2751	2716	2716	2853	2832	2844	2808	2808	101.4	.	57.3
JEEP CHEROKEE 4X4	7005	7007	SML SUV	2917	2918	2983	2937	3043	3033	3000	2985	2985	101.4	.	57.3
JEEP WAGONEER	7006	7008	SML SUV	3047	3050	3083	3080	3491	3453	3453	3394	.	101.4	.	58.0
JEEP GRAND WAGONR	7007	7009	LGE SUV	4221	4252	4509	4505	4470	4499	4377	4377	.	108.7	.	59.5
JEEP COMANCHE LONG	7008	7010	SML PICKUP	.	2926	3006	3006	.	.	.	.	.	119.9	.	57.8
JEEP COMNCH 4X4 LN	7008	7011	SML PICKUP	.	3093	3181	3181	.	.	.	.	.	119.9	.	57.8
JEEP COMANCHE SHRT	7009	7012	SML PICKUP	.	.	2988	2988	.	.	.	.	.	113.0	.	57.8
JEEP COMNCH 4X4 SH	7009	7013	SML PICKUP	.	.	3082	3082	.	.	.	.	.	113.0	.	57.8
JEEP WRANGLER	7010	7014	SML SUV	.	.	2868	2910	2936	2936	2934	2938	2935	93.4	.	57.4
JEEP COMANCHE 89-	7011	7015	SML PICKUP	.	.	.	.	2988	2895	2895	2898	.	113.0	119.9	57.8
JEEP COMNCH4X4 89-	7011	7016	SML PICKUP	.	.	.	.	3082	3084	3084	3075	.	113.0	119.9	57.8
DODG CARAVAN -90	7101	7101	SML VAN	2940	2911	2911	3100	3100	3100	.	.	.	112.0	.	61.0
DODG MINI RAM VAN	7101	7102	SML VAN	2700	2755	2835	2835	2858	2855	.	.	.	112.0	.	61.0
PLYM VOYAGER -90	7101	7201	SML VAN	2940	2911	2911	3100	3100	3100	.	.	.	112.0	.	61.0
DODG D100	7102	7103	LGE PICKUP	3380	3451	3486	3486	3558	3610	3610	.	.	115.0	131.0	65.7
DODG D150	7102	7104	LGE PICKUP	3450	3456	3491	3491	3558	3620	3620	3774	3732	115.0	131.0	65.7
DODG W100	7102	7105	LGE PICKUP	3985	4067	4093	4093	4154	4150	4150	.	.	115.0	131.0	66.5
DODG W150	7102	7106	LGE PICKUP	3995	4072	4098	4098	4154	4150	4150	4237	4149	115.0	131.0	66.5
DODG D250	7103	7107	LGE PICKUP	3840	3851	3919	3919	3979	4035	4035	4112	3866	131.0	.	65.7
DODG W250	7103	7108	LGE PICKUP	4350	4400	4414	4414	4475	4495	4495	4553	4582	131.0	.	66.5
DODG D350	7103	7109	LGE PICKUP	4200	4252	4252	4252	4305	4290	4500	4500	4365	131.0	.	65.7
DODG W350	7103	7110	LGE PICKUP	4500	4542	4542	4542	4868	4845	4845	4860	4881	131.0	.	66.5
DODG D350 CREW CAB	7104	7111	LGE PICKUP	4550	4550	4550	4550	.	.	.	.	.	149.0	165.0	65.7
DODG W350 CREW CAB	7104	7112	LGE PICKUP	4985	4985	4985	4985	.	.	.	.	.	149.0	165.0	66.5
DODG RAMCHARGER	7105	7113	LGE SUV	4000	4045	4106	4106	4198	4265	4265	4264	4233	106.0	.	66.1
DODG RAMCHRGR 4X4	7105	7114	LGE SUV	4500	4530	4583	4583	4638	4645	4635	4687	4580	106.0	.	66.1
DODG B150 CARGO	7106	7115	LGE VAN	3420	3580	3600	3600	3680	3680	3695	3730	3786	109.6	127.6	66.6
DODG B150 WAGON	7106	7116	LGE VAN	3809	3960	3983	3983	3995	3995	4025	4142	4087	109.6	127.6	66.6
DODG B250 CARGO	7106	7117	LGE VAN	3590	3569	3700	3700	3700	3685	3695	3771	3860	109.6	127.6	66.6
DODG B250 WAGON	7107	7118	LGE VAN	4150	4135	4154	4154	4170	4170	4195	4251	4180	127.6	.	66.6
DODG B350 CARGO	7107	7119	LGE VAN	4050	4037	4093	4093	4165	4165	4200	4245	4215	127.6	.	66.6
DODG B350 WAGON	7107	7120	LGE VAN	4550	4550	4537	4537	4570	4570	4570	4611	4555	127.6	.	66.6
DODG DAKOTA	7108	7130	SML PICKUP	.	.	2856	2856	2885	2990	2990	2963	2958	111.9	123.9	59.4
DODG DAKOTA 4X4	7108	7131	SML PICKUP	.	.	3516	3516	3570	3640	3700	3670	3653	111.9	123.9	60.2
DODG GRN CARVN -90	7109	7132	SML VAN	.	.	.	3400	3400	3459	.	.	.	119.1	.	61.0
DODG MINIRAM XT-90	7109	7133	SML VAN	.	.	.	3010	3010	3105	.	.	.	119.1	.	61.0
PLYM GRN VOYGR -90	7109	7202	SML VAN	.	.	.	3400	3400	3459	.	.	.	119.1	.	61.0
CHRY TOWN&CTRY -90	7109	7301	SML VAN	.	.	.	.	.	3817	.	.	.	119.1	.	61.0
DOD D150 CLBCB 90-	7110	7134	LGE PICKUP	.	.	.	.	.	4265	4265	4366	4366	149.0	.	65.7
DOD W150 CLBCB 90-	7110	7135	LGE PICKUP	.	.	.	.	.	4660	4652	4768	4768	149.0	.	66.5
DOD D250 CLBCB 90-	7110	7136	LGE PICKUP	.	.	.	.	.	4380	4380	4483	4483	149.0	.	65.7
DOD W250 CLBCB 90-	7110	7137	LGE PICKUP	.	.	.	.	.	4725	4725	4839	4839	149.0	.	66.5
DOD DAKOTA CLUBCAB	7111	7138	SML PICKUP	.	.	.	.	.	3300	3330	3236	3231	131.0	.	59.4
DOD DAKTA 4 CLBCAB	7111	7139	SML PICKUP	.	.	.	.	.	3840	3900	3895	3878	131.0	.	60.2
DODG CARAVAN 91-	7112	7140	SML VAN	.	.	.	.	.	.	3271	3300	3275	112.3	.	61.0
DODG CARAVAN 4X4	7112	7141	SML VAN	.	.	.	.	.	.	3876	3876	3868	112.3	.	61.0
DODG CARAVAN C/V	7112	7142	SML VAN	.	.	.	.	.	.	3044	3044	3008	112.3	.	61.0

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
DODG CARVN C/V 4X4	7112	7143	SML VAN	.	.	.	.	.	.	3514	3514	3514	112.3	.	61.0
PLYM VOYAGER 91-	7112	7203	SML VAN	.	.	.	.	.	.	3271	3300	3275	112.3	.	61.0
PLYM VOYAGER 4X4	7112	7204	SML VAN	.	.	.	.	.	.	3876	3876	3868	112.3	.	61.0
DODG GRN CARVN 91-	7113	7144	SML VAN	.	.	.	.	.	.	3644	3693	3602	119.3	.	61.0
DODG GRN CARVN 4X4	7113	7145	SML VAN	.	.	.	.	.	.	3995	3995	3989	119.3	.	61.0
DODG CARVN C/V XT	7113	7146	SML VAN	.	.	.	.	.	.	3334	3334	3293	119.3	.	61.0
DOD CARVN C/V 4 XT	7113	7147	SML VAN	.	.	.	.	.	.	3636	3636	3636	119.3	.	61.0
PLYM GRN VOYGR 91-	7113	7205	SML VAN	.	.	.	.	.	.	3644	3693	3602	119.3	.	61.0
PLYM GRN VOYGR 4X4	7113	7206	SML VAN	.	.	.	.	.	.	3995	3995	3989	119.3	.	61.0
CHRY TOWN&CTRY 91-	7113	7302	SML VAN	.	.	.	.	.	.	3946	3946	3946	119.3	.	61.0
CHRY TOWN&CTRY 4X4	7113	7303	SML VAN	.	.	.	.	.	.	.	4228	4228	119.3	.	61.0
JEEP GRND CHEROKEE	7114	7017	SML SUV	.	.	.	.	.	.	.	.	3350	105.9	.	58.7
JEEP GR CHEROK 4X4	7114	7018	SML SUV	.	.	.	.	.	.	.	.	3550	105.9	.	58.7
JEEP GR WAGONR 93	7114	7019	SML SUV	.	.	.	.	.	.	.	.	3750	105.9	.	58.7
FORD RANGER -92	7401	7401	SML PICKUP	2600	2638	2638	2700	2802	2802	2820	2820	.	107.9	113.9	54.5
FORD RANGER4X4 -92	7401	7402	SML PICKUP	2770	2833	2833	2920	2920	3126	3133	3128	.	107.9	113.9	55.5
FORD F-150	7402	7403	LGE PICKUP	3390	3420	3420	3670	3670	3670	3745	3843	3843	116.8	133.0	65.5
FORD F-150 4X4	7402	7404	LGE PICKUP	3820	3805	3805	3965	3965	3965	3898	3996	3966	116.8	133.0	66.5
FORD F-250	7403	7405	LGE PICKUP	3670	3824	3824	3955	3955	3955	4109	4214	4250	133.0	.	65.5
FORD F-250 4X4	7403	7406	LGE PICKUP	4115	4179	4179	4300	4300	4300	4465	4600	4600	133.0	.	66.5
FORD F-350	7403	7407	LGE PICKUP	4070	4070	4070	4370	4370	4370	4500	4600	5650	133.0	.	65.5
FORD F-350 4X4	7403	7408	LGE PICKUP	4425	4425	4425	4725	4725	4725	4917	5005	5050	133.0	.	66.5
FORD F-150 SUPRCAB	7404	7409	LGE PICKUP	3900	3984	3984	4195	4195	4195	4229	4218	4218	138.8	155.0	65.5
FORD F150 4 SUPCAB	7404	7410	LGE PICKUP	4400	4433	4433	4460	4460	4460	4474	4428	4428	138.8	155.0	66.5
FORD F-250 SUPRCAB	7405	7411	LGE PICKUP	4500	4581	4581	4680	4680	4680	4702	4772	4579	155.0	.	65.5
FORD F250 4 SUPCAB	7405	7412	LGE PICKUP	5000	5091	5091	5140	5140	5140	5134	5221	5221	155.0	.	66.5
FORD F-350 SUPRCAB	7405	7413	LGE PICKUP	4830	4830	4830	4895	.	.	.	.	.	155.0	.	65.5
FORD F350 4 SUPCAB	7405	7414	LGE PICKUP	5340	5340	5340	5405	.	.	.	.	.	155.0	.	66.5
FORD F350 DUAL WHL	7405	7431	LGE PICKUP	.	.	.	5405	5405	5405	5297	5389	5300	155.0	.	65.5
FORD BRONCO II 4X4	7406	7415	SML SUV	3239	3213	3213	3269	3371	3371	.	.	.	94.0	.	56.9
FORD BRONCO II	7406	7416	SML SUV	.	3043	3043	3160	3278	3278	.	.	.	94.0	.	56.9
FORD BRONCO	7407	7417	LGE SUV	4360	4383	4383	4383	4400	4453	4416	4430	4430	104.7	.	65.5
FORD E150 CRGO -90	7408	7418	LGE VAN	3800	3874	3874	4010	3950	3950	.	.	.	124.0	138.0	68.0
FORD E150 CRGO 91	7409	7418	LGE VAN	.	.	.	.	.	.	4134	.	.	138.0	.	68.0
FORD E150 SUPR -91	7409	7419	LGE VAN	3970	4036	4036	4425	4359	4359	4422	.	.	138.0	.	68.0
FORD E150 WAGN -91	7409	7420	LGE VAN	4300	4385	4385	4509	4417	4417	4459	.	.	138.0	.	68.0
FORD E250 CRGO -91	7409	7421	LGE VAN	4300	4413	4413	4640	4640	4640	4558	.	.	138.0	.	68.0
FORD E250 SUPR -91	7409	7422	LGE VAN	4420	4586	4586	4810	4810	4810	4748	.	.	138.0	.	68.0
FORD E250 WAGN -91	7409	7423	LGE VAN	5000	5066	5066	5070	5070	5070	5137	.	.	138.0	.	68.0
FORD E350 CRGO -91	7409	7424	LGE VAN	4695	4546	4546	4750	4750	4750	4763	.	.	138.0	.	68.0
FORD E350 SUPR -91	7409	7425	LGE VAN	4875	4728	4728	5060	5060	5060	4927	.	.	138.0	.	68.0
FORD E350 WAGN -91	7409	7426	LGE VAN	5300	5365	5365	5413	5413	5413	5457	.	.	138.0	.	68.0
F RANGR SUPCAB -92	7410	7427	SML PICKUP	.	2842	2842	3000	3133	3133	3128	3128	.	125.0	.	54.5
F RNGR SUCB 4X4-92	7410	7428	SML PICKUP	.	3065	3065	3240	3240	3445	3479	3479	.	125.0	.	55.5
FORD AEROSTAR CRGO	7411	7429	SML VAN	.	2916	2916	3102	3102	3102	3200	3200	3200	118.9	.	60.7
FORD AEROSTAR WAGN	7411	7430	SML VAN	.	3243	3243	3359	3359	3359	3374	3374	3374	118.9	.	60.7
FORD AERSTR CRG XT	7411	7432	SML VAN	.	.	.	.	3202	3270	3294	3294	3294	118.9	.	60.7
FORD AERSTR WGN XT	7411	7433	SML VAN	.	.	.	.	3460	3502	3478	3478	3478	118.9	.	60.7
FORD AERO 4X4 CRGO	7411	7436	SML VAN	.	.	.	.	.	3470	3485	3485	3485	118.9	.	60.7
FORD AERO 4X4 WAGN	7411	7437	SML VAN	.	.	.	.	.	3642	3651	3651	3651	118.9	.	60.7
FORD AERO 4 CRG XT	7411	7438	SML VAN	.	.	.	.	.	3550	3565	3565	3565	118.9	.	60.7

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
FORD AERO 4 WGN XT	7411	7439	SML VAN	.	.	.	.	.	3732	3755	3755	3755	118.9	.	60.7
FORD F350 CREW CAB	7412	7434	LGE PICKUP	.	.	.	.	5095	5095	5094	5178	5005	168.4	.	65.5
FORD F350 4 CRUCAB	7412	7435	LGE PICKUP	.	.	.	.	5435	5435	5446	5630	5630	168.4	.	66.5
FORD EXPLORER 2DR	7413	7440	SML SUV	.	.	.	.	.	.	3681	3675	3675	102.1	.	58.5
FORD EXPLOR 2D 4X4	7413	7441	SML SUV	.	.	.	.	.	.	3824	3854	3854	102.1	.	58.5
MAZDA NAVAJO 4X4	7413	8310	SML SUV	.	.	.	.	.	.	3851	3980	3980	102.1	.	58.5
MAZDA NAVAJO	7413	8311	SML SUV	.	.	.	.	.	.	.	3785	3785	102.1	.	58.5
FORD EXPLORER 4DR	7414	7442	SML SUV	.	.	.	.	.	.	3841	3879	3879	111.9	.	58.5
FORD EXPLOR 4D 4X4	7414	7443	SML SUV	.	.	.	.	.	.	4012	4046	4046	111.9	.	58.5
FORD E150 CRGO 92-	7415	7444	LGE VAN	.	.	.	.	.	.	.	4459	4459	138.0	.	69.0
FORD E150 WAGN 92-	7415	7445	LGE VAN	.	.	.	.	.	.	.	4917	4917	138.0	.	69.0
FORD E250 CRGO 92-	7415	7446	LGE VAN	.	.	.	.	.	.	.	4850	4850	138.0	.	69.0
FORD E250 SUPR 92-	7415	7447	LGE VAN	.	.	.	.	.	.	.	5048	5048	138.0	.	69.0
FORD E350 CRGO 92-	7415	7448	LGE VAN	.	.	.	.	.	.	.	5150	5150	138.0	.	69.0
FORD E350 SUPR 92-	7415	7449	LGE VAN	.	.	.	.	.	.	.	5377	5377	138.0	.	69.0
FORD E350 WAGN 92-	7415	7450	LGE VAN	.	.	.	.	.	.	.	5389	5389	138.0	.	69.0
FORD E350 SUPRWAGN	7415	7451	LGE VAN	.	.	.	.	.	.	.	5689	5689	138.0	.	69.0
FORD RANGER 1993	7416	7452	SML PICKUP	.	.	.	.	.	.	.	.	2918	108.0	114.0	55.9
FORD RANGER 4X4 93	7416	7453	SML PICKUP	.	.	.	.	.	.	.	.	2955	108.0	114.0	56.9
F RANGER SUPCAB 93	7417	7454	SML PICKUP	.	.	.	.	.	.	.	.	3208	125.0	.	55.9
F RNGR SUCB 4X4 93	7417	7455	SML PICKUP	.	.	.	.	.	.	.	.	3250	125.0	.	56.9
MERC VILLAGER CRGO	7418	7501	SML VAN	.	.	.	.	.	.	.	.	3979	112.2	.	.
MERC VILLAGER WAGN	7418	7502	SML VAN	.	.	.	.	.	.	.	.	3979	112.2	.	.
CHEV S10 -87	7601	7601	SML PICKUP	2550	2574	2567	.	.	.	.	.	.	108.3	122.9	54.4
CHEV T10 -87	7601	7602	SML PICKUP	2950	2905	2913	.	.	.	.	.	.	108.3	122.9	55.9
GMC S15 -87	7601	7701	SML PICKUP	2550	2574	2567	.	.	.	.	.	.	108.3	122.9	54.4
GMC T15 -87	7601	7702	SML PICKUP	2950	2905	2913	.	.	.	.	.	.	108.3	122.9	55.9
CHEV C/R 10 PU -87	7602	7603	LGE PICKUP	3450	3432	3432	3432	.	.	.	.	.	117.5	155.5	63.5
CHEV K/V 10 PU -87	7602	7604	LGE PICKUP	4030	4030	4030	4030	.	.	.	.	.	117.5	155.5	63.5
GMC C/R 15 PU -87	7602	7703	LGE PICKUP	3450	3432	3432	3432	.	.	.	.	.	117.5	155.5	63.5
GMC K/V 15 PU -87	7602	7704	LGE PICKUP	4030	4030	4030	4030	.	.	.	.	.	117.5	155.5	63.5
CHEV C/R 20 PU -87	7603	7605	LGE PICKUP	4025	3950	3950	.	.	.	.	.	.	131.5	155.5	66.9
CHEV K/V 20 PU -87	7603	7606	LGE PICKUP	4450	4370	4370	.	.	.	.	.	.	131.5	155.5	66.9
CHEV C/R 30 PU -87	7603	7607	LGE PICKUP	4405	4426	4364	4364	4364	.	.	.	.	131.5	155.5	66.9
CHEV K/V 30 PU -87	7603	7608	LGE PICKUP	4825	4846	4784	4784	4784	.	.	.	.	131.5	155.5	66.9
GMC C/R 25 PU -87	7603	7705	LGE PICKUP	4025	3950	3950	.	.	.	.	.	.	131.5	155.5	66.9
GMC K/V 25 PU -87	7603	7706	LGE PICKUP	4450	4370	4370	.	.	.	.	.	.	131.5	155.5	66.9
GMC C/R 35 PU -87	7603	7707	LGE PICKUP	4405	4426	4364	4364	4364	.	.	.	.	131.5	155.5	66.9
GMC K/V 35 PU -87	7603	7708	LGE PICKUP	4825	4846	4784	4784	4784	.	.	.	.	131.5	155.5	66.9
CHEV S BLAZER 2DR	7604	7609	SML SUV	2893	2897	2881	2870	3030	3100	3189	3186	3198	100.5	.	55.9
CHV S BLAZR 4X4 2D	7604	7610	SML SUV	3139	3152	3149	3156	3319	3400	3481	3486	3512	100.5	.	55.9
GMC S JIMMY 2DR	7604	7709	SML SUV	2893	2897	2881	2870	3030	3100	3189	3186	3198	100.5	.	55.9
GMC S JIMMY 4X4 2D	7604	7710	SML SUV	3139	3152	3149	3156	3319	3400	3481	3486	3512	100.5	.	55.9
CHEV K/V BLAZR -91	7605	7611	LGE SUV	4409	4415	4692	4703	4550	4540	4507	.	.	106.5	.	67.3
GMC K/V JIMMY -91	7605	7711	LGE SUV	4409	4415	4692	4703	4550	4540	4507	.	.	106.5	.	67.3
CHV CR10 SUBRB -91	7606	7612	LGE SUV	4310	4279	4346	4346	4433	4433	4433	.	.	129.5	.	63.5
CHV KV10 SUBRB -91	7606	7613	LGE SUV	4708	4686	4800	4800	4675	4675	4800	.	.	129.5	.	66.5
GMC CR10 SUBRB -91	7606	7712	LGE SUV	4310	4279	4346	4346	4433	4433	4433	.	.	129.5	.	63.5
GMC KV10 SUBRB -91	7606	7713	LGE SUV	4708	4686	4800	4800	4675	4675	4800	.	.	129.5	.	66.5
CHV CR20 SUBRB -91	7607	7614	LGE SUV	4698	4771	4900	4900	4900	4900	4900	.	.	129.5	.	63.5
CHV KV20 SUBRB -91	7607	7615	LGE SUV	4976	5058	5200	5200	5200	5200	5200	.	.	129.5	.	66.5

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
GMC CR20 SUBRB -91	7607	7714	LGE SUV	4698	4771	4900	4900	4900	4900	4900	.	.	129.5	.	63.5
GMC KV20 SUBRB -91	7607	7715	LGE SUV	4976	5058	5200	5200	5200	5200	5200	.	.	129.5	.	66.5
CHEV ASTRO CARGO	7608	7616	SML VAN	3084	3078	3088	3088	3108	3108	3554	3554	3554	111.0	.	65.1
CHEV ASTRO PASSGR	7608	7617	SML VAN	3492	3450	3450	3454	3586	3586	3909	3909	3909	111.0	.	65.1
CHE ASTRO CRGO XTD	7608	7644	SML VAN	.	.	.	.	.	3554	3618	3618	3618	111.0	.	65.1
CHE ASTRO PSGR XTD	7608	7645	SML VAN	.	.	.	.	.	3803	3993	3993	3993	111.0	.	65.1
CHE ASTRO CRGO 4X4	7608	7646	SML VAN	.	.	.	.	.	3798	3856	3856	3856	111.0	.	65.1
CHE ASTRO PSGR 4X4	7608	7647	SML VAN	.	.	.	.	.	4160	4182	4182	4182	111.0	.	65.1
CHE ASTR CRG XT4X4	7608	7648	SML VAN	.	.	.	.	.	3842	3917	3917	3917	111.0	.	65.1
CHE ASTR PSG XT4X4	7608	7649	SML VAN	.	.	.	.	.	4221	4259	4259	4259	111.0	.	65.1
GMC SAFARI CARGO	7608	7716	SML VAN	3084	3078	3088	3088	3108	3108	3554	3554	3554	111.0	.	65.1
GMC SAFARI PASSGR	7608	7717	SML VAN	3492	3450	3450	3454	3586	3586	3909	3909	3909	111.0	.	65.1
GMC SAFRI CRGO XTD	7608	7744	SML VAN	.	.	.	.	.	3554	3618	3618	3618	111.0	.	65.1
GMC SAFRI PSGR XTD	7608	7745	SML VAN	.	.	.	.	.	3803	3993	3993	3993	111.0	.	65.1
GMC SAFRI CRGO 4X4	7608	7746	SML VAN	.	.	.	.	.	3798	3856	3856	3856	111.0	.	65.1
GMC SAFRI PSGR 4X4	7608	7747	SML VAN	.	.	.	.	.	4160	4182	4182	4182	111.0	.	65.1
GMC SAFR CRG XT4X4	7608	7748	SML VAN	.	.	.	.	.	3842	3917	3917	3917	111.0	.	65.1
GMC SAFR PSG XT4X4	7608	7749	SML VAN	.	.	.	.	.	4221	4259	4259	4259	111.0	.	65.1
CHEVY VAN G10	7609	7618	LGE VAN	3734	3740	3743	3743	3743	3743	3792	3860	3860	110.0	125.0	68.4
CHEV SPORTVAN G10	7609	7619	LGE VAN	4100	4100	4076	4076	4076	4076	4150	4208	4208	110.0	125.0	68.4
CHEVY VAN G20	7609	7620	LGE VAN	3815	3786	3796	3796	3796	3796	3836	3887	3887	110.0	125.0	68.4
GMC VANDURA 1500	7609	7718	LGE VAN	3734	3740	3743	3743	3743	3743	3792	3860	3860	110.0	125.0	68.4
GMC RALLY 1500	7609	7719	LGE VAN	4100	4100	4076	4076	4076	4076	4150	4208	4208	110.0	125.0	68.4
GMC VANDURA 2500	7609	7720	LGE VAN	3815	3786	3796	3796	3796	3796	3836	3887	3887	110.0	125.0	68.4
CHEV SPORTVAN G20	7610	7621	LGE VAN	4277	4244	4259	4259	4259	4259	4481	4540	4540	125.0	.	68.4
CHEVY VAN G30	7610	7622	LGE VAN	4405	4526	4453	4453	4453	4453	4510	4572	4572	125.0	.	68.4
CHEV SPORTVAN G30	7610	7623	LGE VAN	4730	4867	4773	4773	4773	4773	5077	5097	5097	125.0	.	68.4
GMC RALLY 2500	7610	7721	LGE VAN	4277	4244	4259	4259	4259	4259	4481	4540	4540	125.0	.	68.4
GMC VANDURA 3500	7610	7722	LGE VAN	4405	4526	4453	4453	4453	4453	4510	4572	4572	125.0	.	68.4
GMC RALLY 3500	7610	7723	LGE VAN	4730	4867	4773	4773	4773	4773	5077	5097	5097	125.0	.	68.4
CHEV EL CAMINO	7611	7624	PICKUP CAR	3234	3234	3234	.	.	.	.	.	.	117.1	.	.
GMC CABALLERO	7611	7724	PICKUP CAR	3234	3234	3234	.	.	.	.	.	.	117.1	.	.
CHV CR20 4D PU -91	7612	7625	LGE PICKUP	4775	4800	4800	4800	4800	.	.	.	.	164.5	.	66.9
CHV KV20 4D PU -91	7612	7626	LGE PICKUP	5195	5220	5220	5220	5220	.	.	.	.	164.5	.	66.9
CHV CR30 4D PU -91	7612	7627	LGE PICKUP	4850	4900	4900	4900	4900	4871	4900	.	.	164.5	.	66.9
CHV KV30 4D PU -91	7612	7628	LGE PICKUP	5270	5320	5320	5320	5320	5343	5343	.	.	164.5	.	66.9
GMC CR25 4D PU -91	7612	7725	LGE PICKUP	4775	4800	4800	4800	4800	.	.	.	.	164.5	.	66.9
GMC KV25 4D PU -91	7612	7726	LGE PICKUP	5195	5220	5220	5220	5220	.	.	.	.	164.5	.	66.9
GMC CR35 4D PU -91	7612	7727	LGE PICKUP	4850	4900	4900	4900	4900	4871	4900	.	.	164.5	.	66.9
GMC KV35 4D PU -91	7612	7728	LGE PICKUP	5270	5320	5320	5320	5320	5343	5343	.	.	164.5	.	66.9
CHEV S10 88-	7613	7601	SML PICKUP	.	.	.	2570	2648	2648	2671	2665	2635	108.3	117.9	54.4
CHEV T10 88-	7613	7602	SML PICKUP	.	.	.	2919	3103	3103	3241	3237	3235	108.3	117.9	55.9
GMC SONOMA	7613	7701	SML PICKUP	.	.	.	2570	2648	2648	2671	2665	2635	108.3	117.9	54.4
GMC SONOMA 4X4	7613	7702	SML PICKUP	.	.	.	2919	3103	3103	3241	3237	3235	108.3	117.9	55.9
CHEV S10 MAXICAB	7614	7629	SML PICKUP	.	.	.	2690	2774	2774	2793	2826	2834	122.9	.	54.4
CHEV T10 MAXICAB	7614	7630	SML PICKUP	.	.	.	3039	3231	3231	3366	3360	3367	122.9	.	55.9
GMC SONOMA MAXICAB	7614	7729	SML PICKUP	.	.	.	2690	2774	2774	2793	2826	2834	122.9	.	54.4
GMC SONOMA4X4 XCAB	7614	7730	SML PICKUP	.	.	.	3039	3231	3231	3366	3360	3367	122.9	.	55.9
CHEV C10 PU 88-	7615	7631	LGE PICKUP	.	.	.	3661	3692	3692	3692	3718	3718	117.5	131.5	63.5
CHEV K10 PU 88-	7615	7632	LGE PICKUP	.	.	.	4096	4067	4067	4111	4111	4111	117.5	131.5	63.5
GMC C1500 PU 88-	7615	7731	LGE PICKUP	.	.	.	3661	3692	3692	3692	3718	3718	117.5	131.5	63.5
GMC K1500 PU 88-	7615	7732	LGE PICKUP	.	.	.	4096	4067	4067	4111	4111	4111	117.5	131.5	63.5

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
CHEV C20 PU 88-	7616	7633	LGE PICKUP	.	.	.	3933	3909	3909	4003	4023	4023	131.5	.	66.9
CHEV K20 PU 88-	7616	7634	LGE PICKUP	.	.	.	4284	4238	4238	4352	4384	4384	131.5	.	66.9
CHEV C30 PU 88-	7616	7635	LGE PICKUP	.	.	.	4424	4349	4349	4500	4636	4636	131.5	.	66.9
CHEV K30 PU 88-	7616	7636	LGE PICKUP	.	.	.	4783	4733	4733	4875	5042	5042	131.5	.	66.9
GMC C2500 PU 88-	7616	7733	LGE PICKUP	.	.	.	3933	3909	3909	4003	4023	4023	131.5	.	66.9
GMC K2500 PU 88-	7616	7734	LGE PICKUP	.	.	.	4284	4238	4238	4352	4384	4384	131.5	.	66.9
GMC C3500 PU 88-	7616	7735	LGE PICKUP	.	.	.	4424	4349	4349	4500	4636	4636	131.5	.	66.9
GMC K3500 PU 88-	7616	7736	LGE PICKUP	.	.	.	4783	4733	4733	4875	5042	5042	131.5	.	66.9
CHE C10 XCAB 88-90	7617	7637	LGE PICKUP	.	.	.	4074	4091	4091	.	.	.	155.5	.	66.9
CHE K10 XCAB 88-90	7617	7638	LGE PICKUP	.	.	.	4520	4522	4522	.	.	.	155.5	.	66.9
CHE C20 XCAB 88-90	7617	7639	LGE PICKUP	.	.	.	4223	4185	4185	.	.	.	155.5	.	66.9
CHE K20 XCAB 88-90	7617	7640	LGE PICKUP	.	.	.	4579	4552	4552	.	.	.	155.5	.	66.9
CHEV C30 XCAB 88-	7617	7641	LGE PICKUP	.	.	.	4693	4625	4696	4850	4981	4981	155.5	.	66.9
CHEV K30 XCAB 88-	7617	7642	LGE PICKUP	.	.	.	5061	5022	5022	5150	5290	5290	155.5	.	66.9
GMC C15 XCAB 88-90	7617	7737	LGE PICKUP	.	.	.	4074	4091	4091	.	.	.	155.5	.	66.9
GMC K15 XCAB 88-90	7617	7738	LGE PICKUP	.	.	.	4520	4522	4522	.	.	.	155.5	.	66.9
GMC C25 XCAB 88-90	7617	7739	LGE PICKUP	.	.	.	4223	4185	4185	.	.	.	155.5	.	66.9
GMC K25 XCAB 88-90	7617	7740	LGE PICKUP	.	.	.	4579	4552	4552	.	.	.	155.5	.	66.9
GMC C35 XCAB 88-	7617	7741	LGE PICKUP	.	.	.	4693	4625	4696	4850	4981	4981	155.5	.	66.9
GMC K35 XCAB 88-	7617	7742	LGE PICKUP	.	.	.	5061	5022	5022	5150	5290	5290	155.5	.	66.9
CHEVY VAN G30 XTD	7618	7650	LGE VAN	.	.	.	.	.	4643	4783	4852	4852	146.0	.	68.4
CHE SPRTVN G30 XTD	7618	7651	LGE VAN	.	.	.	.	.	5443	5527	5635	5635	146.0	.	68.4
GMC VANDURA 35 XTD	7618	7750	LGE VAN	.	.	.	.	.	4643	4783	4852	4852	146.0	.	68.4
GMC RALLY 3500 XTD	7618	7751	LGE VAN	.	.	.	.	.	5443	5527	5635	5635	146.0	.	68.4
CHEV LUMINA APV	7619	7652	SML VAN	.	.	.	.	.	3495	3495	3558	3558	109.8	.	59.8
CHEV APV CARGO VAN	7619	7667	SML VAN	.	.	.	.	.	.	.	3370	3370	109.8	.	59.8
OLDS SILHOUETTE	7619	7801	SML VAN	.	.	.	.	.	3600	3648	3735	3735	109.8	.	59.8
PONT TRANS SPORT	7619	7901	SML VAN	.	.	.	.	.	3553	3514	3599	3599	109.8	.	59.8
CHEV C10 XCAB 91-	7620	7653	LGE PICKUP	.	.	.	.	.	.	4051	3998	3998	141.5	155.5	66.9
CHEV K10 XCAB 91-	7620	7654	LGE PICKUP	.	.	.	.	.	.	4450	4426	4426	141.5	155.5	66.9
CHEV C20 XCAB 91-	7620	7655	LGE PICKUP	.	.	.	.	.	.	4161	4131	4131	141.5	155.5	66.9
CHEV K20 XCAB 91-	7620	7656	LGE PICKUP	.	.	.	.	.	.	4482	4481	4481	141.5	155.5	66.9
GMC C15 XCAB 91-	7620	7753	LGE PICKUP	.	.	.	.	.	.	4051	3998	3998	141.5	155.5	66.9
GMC K15 XCAB 91-	7620	7754	LGE PICKUP	.	.	.	.	.	.	4450	4426	4426	141.5	155.5	66.9
GMC C25 XCAB 91-	7620	7755	LGE PICKUP	.	.	.	.	.	.	4161	4131	4131	141.5	155.5	66.9
GMC K25 XCAB 91-	7620	7756	LGE PICKUP	.	.	.	.	.	.	4482	4481	4481	141.5	155.5	66.9
CHEV S BLAZER 4DR	7621	7657	SML SUV	.	.	.	.	.	.	3433	3312	3365	107.0	.	55.9
CHV S BLAZR 4X4 4D	7621	7658	SML SUV	.	.	.	.	.	.	3721	3697	3748	107.0	.	55.9
GMC S JIMMY 4DR	7621	7757	SML SUV	.	.	.	.	.	.	3433	3312	3365	107.0	.	55.9
GMC S JIMMY 4X4 4D	7621	7758	SML SUV	.	.	.	.	.	.	3721	3697	3748	107.0	.	55.9
OLDS BRAVADA	7621	7802	SML SUV	.	.	.	.	.	.	3939	3939	4002	107.0	.	55.9
CHEV C30 4DR 92-	7622	7660	LGE PICKUP	.	.	.	.	.	.	.	5279	5279	168.5	.	66.9
CHEV K30 4DR 92-	7622	7661	LGE PICKUP	.	.	.	.	.	.	.	5652	5652	168.5	.	66.9
GMC C35 4DR 92-	7622	7760	LGE PICKUP	.	.	.	.	.	.	.	5279	5279	168.5	.	66.9
GMC K35 4DR 92-	7622	7761	LGE PICKUP	.	.	.	.	.	.	.	5652	5652	168.5	.	66.9
CHEV K BLAZER 92-	7623	7662	LGE SUV	.	.	.	.	.	.	.	4676	4733	111.5	.	.
GMC YUKON	7623	7762	LGE SUV	.	.	.	.	.	.	.	4676	4733	111.5	.	.
CHEV C10 SUBRB 92-	7624	7663	LGE SUV	.	.	.	.	.	.	.	4701	4701	131.5	.	.
CHEV K10 SUBRB 92-	7624	7664	LGE SUV	.	.	.	.	.	.	.	5169	5169	131.5	.	.
GMC C10 SUBURB 92-	7624	7763	LGE SUV	.	.	.	.	.	.	.	4701	4701	131.5	.	.
GMC K10 SUBURB 92-	7624	7764	LGE SUV	.	.	.	.	.	.	.	5169	5169	131.5	.	.
CHEV C20 SUBRB 92-	7625	7665	LGE SUV	.	.	.	.	.	.	.	5123	5123	131.5	.	.

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
CHEV K20 SUBRB 92-	7625	7666	LGE SUV	.	.	.	.	.	.	.	5535	5535	131.5	.	.
GMC C20 SUBURB 92-	7625	7765	LGE SUV	.	.	.	.	.	.	.	5123	5123	131.5	.	.
GMC K20 SUBURB 92-	7625	7766	LGE SUV	.	.	.	.	.	.	.	5535	5535	131.5	.	.
VW VANAGON	8001	8001	SML VAN	3270	3270	3460	3460	3460	3460	3460	.	.	96.9	.	62.1
VW VANAGON CAMPER	8001	8002	SML VAN	3432	3432	3622	3622	3622	3622	3622	.	.	96.9	.	62.1
NISS PU SHORT -86	8101	8101	SML PICKUP	2619	2619	.	.	.	.	.	.	.	101.4	.	52.4
NISS PU 4X4 SH -86	8101	8102	SML PICKUP	3049	3049	.	.	.	.	.	.	.	101.4	.	52.4
NISS PU LONG -86	8102	8103	SML PICKUP	2701	2701	.	.	.	.	.	.	.	110.8	.	52.4
NISS PU KNGCAB -86	8102	8104	SML PICKUP	2720	2720	.	.	.	.	.	.	.	110.8	.	52.4
NIS PU 4X4 LNG -86	8102	8105	SML PICKUP	3131	3131	.	.	.	.	.	.	.	110.8	.	52.4
NIS PU 4X4 KCB -86	8102	8106	SML PICKUP	3131	3134	.	.	.	.	.	.	.	110.8	.	52.4
NISS PU SHORT 86-	8103	8107	SML PICKUP	.	2715	2715	2715	2715	2715	2740	2740	2740	104.3	.	54.7
NISS PU 4X4 SH 86-	8103	8108	SML PICKUP	.	3270	3270	3275	3275	3275	3300	3300	3300	104.3	.	54.7
NISS PU LONG 86-	8104	8109	SML PICKUP	.	2795	2795	2785	2785	2785	2810	2810	2810	116.1	.	54.7
NISS PU KNGCAB 86-	8104	8110	SML PICKUP	.	2835	2835	2825	2830	2830	2835	2835	2835	116.1	.	54.7
NIS PU 4X4 LNG 86-	8104	8111	SML PICKUP	.	3370	3370	3385	3385	3385	3410	3410	3410	116.1	.	54.7
NIS PU 4X4 KCB 86-	8104	8112	SML PICKUP	.	3480	3480	3400	3405	3405	3430	3430	3430	116.1	.	54.7
NIS PTHFNDR 2D 4X4	8105	8113	SML SUV	.	.	3500	3735	3735	3810	.	.	.	104.3	.	55.8
NISS PATHFINDER 2D	8105	8115	SML SUV	.	.	.	.	3520	3520	.	.	.	104.3	.	55.8
NISS PATHFINDER 4D	8105	8116	SML SUV	.	.	.	.	.	3520	3520	3520	3520	104.3	.	57.5
NIS PTHFNDR 4D 4X4	8105	8117	SML SUV	.	.	.	.	.	3798	3798	3795	3795	104.3	.	57.5
NISS VAN	8106	8114	SML VAN	.	.	3265	3330	3330	3330	.	.	.	92.5	.	55.7
NISSAN QUEST	8107	8118	SML VAN	.	.	.	.	.	.	.	.	3979	112.2	.	63.4
ISUZ PUP SHORT -87	8201	8201	SML PICKUP	2410	2410	2410	.	.	.	.	.	.	104.3	.	52.5
ISU PUP 4X4 SH -87	8201	8202	SML PICKUP	2651	2795	2795	.	.	.	.	.	.	104.3	.	53.4
ISUZ PUP LONG -87	8202	8203	SML PICKUP	2504	2560	2560	.	.	.	.	.	.	117.9	.	52.5
ISU PUP 4X4 LN -87	8202	8204	SML PICKUP	2745	2935	2935	.	.	.	.	.	.	117.9	.	53.4
ISU PUP SPACAB -87	8202	8206	SML PICKUP	.	2580	2580	.	.	.	.	.	.	117.9	.	52.5
ISU PU4X4 SPCAB-87	8202	8207	SML PICKUP	.	2955	2955	.	.	.	.	.	.	117.9	.	53.4
ISUZ TROOPER II	8203	8205	SML SUV	3017	3246	3246	3500	3600	3600	3650	.	.	104.3	.	54.9
ISUZ PUP SHORT 88-	8204	8208	SML PICKUP	.	.	.	2620	2625	2625	2625	2625	2700	105.6	.	56.4
ISU PUP 4X4 SH 88-	8204	8209	SML PICKUP	.	.	.	3125	3130	3130	3130	3130	3215	105.6	.	56.8
ISUZ PUP LONG 88-	8205	8210	SML PICKUP	.	.	.	2720	2725	2725	2725	2725	2810	119.2	.	56.4
ISU PUP 4X4 LN 88-	8205	8211	SML PICKUP	.	.	.	3225	3230	3230	3230	3230	3300	119.2	.	56.8
ISU PUP SPACAB 88-	8205	8212	SML PICKUP	.	.	.	2910	2915	2915	2915	2915	3000	119.2	.	56.4
ISU PU4X4 SPCB 88-	8205	8213	SML PICKUP	.	.	.	3305	3310	3310	3310	3310	3400	119.2	.	56.8
ISUZ 1 TON PU LONG	8205	8214	SML PICKUP	.	.	.	2850	2855	2855	2855	2855	2900	119.2	.	56.4
ISUZ AMIGO	8206	8215	SML SUV	.	.	.	.	2950	2985	2985	3000	3000	91.7	.	57.6
ISUZ AMIGO 4X4	8206	8216	SML SUV	.	.	.	.	3265	3265	3265	3285	3400	91.7	.	57.6
ISU TROOPER2 SHORT	8207	8217	SML SUV	.	.	.	.	3575	3575	.	.	.	90.6	.	54.9
ISUZU RODEO	8208	8218	SML SUV	.	.	.	.	.	.	3500	3500	3535	108.7	.	57.0
ISUZU RODEO 4X4	8208	8219	SML SUV	.	.	.	.	.	.	3725	3725	3770	108.7	.	57.0
ISUZ TROOPER 4DR	8209	8220	SML SUV	.	.	.	.	.	.	.	4155	4210	108.7	.	.
ISUZ TROOPER 2DR	8210	8221	SML SUV	.	.	.	.	.	.	.	.	4060	91.7	.	.
MAZDA PU SHORT BED	8301	8301	SML PICKUP	.	2650	2650	2660	2660	2660	2660	2660	2660	108.7	.	52.1
MAZDA PU 4X4 SHORT	8301	8304	SML PICKUP	.	.	3190	3190	3190	3305	3305	3305	3305	108.7	.	52.1
MAZDA PU LONG BED	8302	8302	SML PICKUP	.	2710	2710	2730	2730	2730	2730	2790	2790	117.5	.	52.1
MAZDA PU CAB PLUS	8302	8303	SML PICKUP	.	2770	2770	2790	2790	2790	2790	2790	2790	117.5	.	52.1

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
MAZDA PU 4X4 LONG	8302	8305	SML PICKUP	.	.	3225	3225	3225	3340	3340	3340	3340	117.5	.	52.1
MAZDA 4X4 CAB PLUS	8302	8306	SML PICKUP	.	.	3315	3315	3315	3430	3430	3430	3430	117.5	.	52.1
MAZDA MPV CARGO	8303	8307	SML VAN	.	.	.	.	3199	3199	3199	3295	3295	110.4	.	60.9
MAZDA MPV WAGON	8303	8308	SML VAN	.	.	.	.	3463	3459	3459	3515	3515	110.4	.	60.9
MAZDA MPV 4X4 WAGN	8303	8309	SML VAN	.	.	.	.	3920	3920	3928	4010	4010	110.4	.	60.9
SUBARU BRAT	8401	8401	PICKUP CAR	2245	2205	2205	.	.	.	.	.	.	96.3	.	53.8
TOYO PU SHORT	8501	8501	SML PICKUP	2515	2515	2515	2565	2565	2565	2620	2730	2640	103.0	.	53.5
TOYO PU 4X4 SHORT	8501	8502	SML PICKUP	3040	3040	3040	3320	3320	3320	3335	3335	3335	103.3	.	55.8
TOYO PU LONG	8502	8503	SML PICKUP	2570	2555	2555	2725	2725	2725	2775	2785	2725	112.2	.	53.5
TOYO PU 4X4 LONG	8502	8504	SML PICKUP	3140	3140	3140	3375	3375	3375	3360	3360	3360	112.2	.	55.8
TOYO PU XTRACAB	8502	8505	SML PICKUP	2715	2715	2715	2740	.	.	.	.	.	112.2	.	53.5
TOYO PU 4X4 XTRCAB	8502	8506	SML PICKUP	3200	3160	3160	3390	.	.	.	.	.	112.2	.	55.8
TOYO 4RUNNER 4X4	8503	8507	SML SUV	3355	3305	3305	3605	3605	3720	3720	3800	3800	103.0	.	56.2
TOYO 4RUNNER	8503	8515	SML SUV	.	.	.	.	.	3590	3590	3740	3740	103.3	.	56.2
TOYO PASSENGER VAN	8504	8508	SML VAN	2925	2995	2995	3020	3038	.	.	.	.	88.0	.	55.9
TOYO CARGO VAN	8504	8509	SML VAN	2825	2825	2825	2830	2851	.	.	.	.	88.0	.	55.9
TOYO PASGR VAN 4X4	8504	8512	SML VAN	.	.	3450	3450	3455	.	.	.	.	88.0	.	55.9
TOYO CARGO VAN 4X4	8504	8513	SML VAN	.	.	3275	3275	3320	.	.	.	.	88.0	.	55.9
TOYO LANDCRUSR -90	8505	8510	LGE SUV	4480	4480	4480	4480	4480	4480	.	.	.	107.5	.	58.2
TOYO PU LONG XCAB	8506	8511	SML PICKUP	.	2570	2570	2815	2815	2815	2900	2915	2875	121.5	.	53.5
TOYO LONG XCAB 4X4	8506	8514	SML PICKUP	.	.	.	.	3480	3480	3460	3460	3530	121.5	.	55.8
TOYO LANDCRUSR 91-	8507	8516	LGE SUV	.	.	.	.	.	.	4597	4597	4760	112.2	.	62.5
TOYO PREVIA	8508	8517	SML VAN	.	.	.	.	.	.	3455	3455	3535	112.8	.	61.4
TOYO PREVIA 4X4	8508	8518	SML VAN	.	.	.	.	.	.	3670	3670	3765	112.8	.	61.4
TOYO T100	8509	8519	LGE PICKUP	.	.	.	.	.	.	.	.	3350	121.8	.	62.6
TOYO T100 1 TON	8509	8520	LGE PICKUP	.	.	.	.	.	.	.	.	3430	121.8	.	62.6
TOYO T100 4X4	8509	8521	LGE PICKUP	.	.	.	.	.	.	.	.	3845	121.8	.	62.6
DODG RAM-50 PU -86	8601	7121	SML PICKUP	2430	2437	.	.	.	.	.	.	.	109.4	.	53.1
DODG RAM50 4X4 -86	8601	7122	SML PICKUP	3039	3039	.	.	.	.	.	.	.	109.8	.	54.6
MITS MIGHTYMAX -86	8601	8601	SML PICKUP	2500	2485	.	.	.	.	.	.	.	109.4	.	53.1
MITS MIMAX 4X4 -86	8601	8602	SML PICKUP	3037	3083	.	.	.	.	.	.	.	109.8	.	54.6
DODG RAIDER	8602	7123	SML SUV	.	.	3175	3175	3115	3115	.	.	.	92.5	.	55.0
MIT MONTERO 2D -91	8602	8603	SML SUV	3260	3260	3260	3273	3200	3413	3413	.	.	92.5	.	55.0
DODG RAM-50 SH 87-	8603	7124	SML PICKUP	.	.	2555	2555	2555	2555	2580	2580	2585	105.1	.	55.4
DOD RM50 4X4SH 87-	8603	7125	SML PICKUP	.	.	3020	3020	3020	3020	2985	2985	2995	105.5	.	55.4
MITS PU SHORT 87-	8603	8604	SML PICKUP	.	.	2545	2545	2545	2545	2570	2570	2570	105.1	.	55.4
MITS PU 4X4 SH 87-	8603	8605	SML PICKUP	.	.	3030	3030	3030	3030	3030	3030	3030	105.5	.	55.4
DODG RAM-50 LONG	8604	7126	SML PICKUP	.	.	2735	2735	2735	2735	2690	2690	2695	116.1	.	55.4
DODG RAM50 4X4LONG	8604	7127	SML PICKUP	.	.	3125	3125	3125	3125	3285	3285	3295	116.5	.	55.4
DODG RAM-50 XCAB	8604	7128	SML PICKUP	.	.	2785	2795	2795	2795	2750	2750	2755	116.1	.	55.4
DODG RAM50 4X4 XCB	8604	7129	SML PICKUP	.	.	3175	3195	3195	3195	3350	3350	3360	116.5	.	55.4
MITS PU LONG BED	8604	8606	SML PICKUP	.	.	2745	2788	2788	2788	2788	2788	2788	116.1	.	55.4
MITS PU 4X4 LONG	8604	8607	SML PICKUP	.	.	3130	3183	3138	3138	3138	3138	3138	116.5	.	55.4
MITS PU MACROCAB	8604	8608	SML PICKUP	.	.	2795	2815	2815	2815	2815	2815	2815	116.1	.	55.4
MITS PU 4X4 XTDCAB	8604	8609	SML PICKUP	.	.	3180	3220	3220	3220	3220	3220	3220	116.5	.	55.4
MITS CARGO VAN	8605	8610	SML VAN	.	.	2910	2910	2910	2910	.	.	.	88.0	.	55.6
MITS PASSENGER VAN	8605	8611	SML VAN	.	.	3285	3285	3285	3285	.	.	.	88.0	.	55.6
MIT MONTERO 4D -91	8606	8612	SML SUV	.	.	.	.	3781	3781	3924	.	.	106.1	.	55.0
MIT MONTERO 4D 92-	8607	8613	SML SUV	.	.	.	.	.	.	.	4130	4130	107.3	.	.

Make-Model Name	CG	MM2	TRKTYP	WT85	WT86	WT87	WT88	WT89	WT90	WT91	WT92	WT93	WHLBS	WBLNG	TRAK
SUZUKI SAMURAI 4X4	8701	8701	SML SUV	2100	2100	2100	2100	2100	2125	2125	2061	2061	79.9	.	51.4
SUZUKI SAMURAI	8701	8706	SML SUV	.	.	.	.	.	.	1955	1995	1995	79.9	.	51.4
GEO TRACKER 4X4	8702	7643	SML SUV	.	.	.	.	2250	2250	2250	2365	2365	86.6	.	55.0
GEO TRACKER	8702	7659	SML SUV	.	.	.	.	.	.	2092	2189	2189	86.6	.	55.0
SUZU SIDEKICK 2DR	8702	8702	SML SUV	.	.	.	.	2134	2134	2134	2134	2134	86.6	.	55.0
SUZ SIDKICK 2D 4X4	8702	8703	SML SUV	.	.	.	.	2200	2200	2200	2200	2200	86.6	.	55.0
SUZU SIDEKICK 4DR	8703	8704	SML SUV	.	.	.	.	.	.	2590	2590	2590	97.6	.	55.0
SUZ SIDKICK 4D 4X4	8703	8705	SML SUV	.	.	.	.	.	.	2660	2660	2660	97.6	.	55.0
DAIHATSU ROCKY	8801	8801	SML SUV	.	.	.	.	.	2794	2800	2800	.	85.6	.	.

APPENDIX F

SUMMARY AND RESPONSE TO TRB's RECOMMENDATIONS ON THE DRAFT REPORT

A draft report on the *Relationships between Vehicle Size and Fatality Risk* was completed in October 1995. Because of the complexity and the high public interest in the issue of vehicle size and safety, NHTSA arranged for a peer review of the draft report by a panel of experts under the auspices of the Transportation Research Board (TRB) of the National Academy of Sciences. The panel completed its review in June 1996. The chairman, D. Warner North, submitted the panel's findings and recommendations in a letter, dated June 12, 1996, from the Transportation Research Board to Ricardo Martinez, M.D., the NHTSA Administrator. That letter, and its accompanying *Appendix B - Technical Issues* recommended a number of supplementary analyses to validate or clarify the material in the October 1995 draft. This report has been revised to address the principal concerns raised by TRB. Here is a list of issues raised by TRB in their peer review, describing TRB's critique and recommended remedies - and, in response, the analyses that were used to address the issue, and the location of the analyses in this revised report.

CONFIDENCE BOUNDS *TRB recommended that the principal estimates of the change in fatalities or injuries, per 100-pound weight reduction, should be stated as interval estimates, i.e., with confidence bounds. Otherwise, readers might attach to the estimates a level of certainty that is not warranted by the data. Additionally, TRB cautioned that the multi-step estimation procedure used in the report could introduce additional sampling or nonsampling error; they recommended that the confidence bounds make room for the possibility of additional error.*

RESPONSE The October 1995 draft included analyses of the statistical significance and relative error of the regression coefficients for vehicle weight. These analyses have been extended to develop confidence bounds for the estimated change in fatalities per 100-pound weight reduction. The bounds are shown in Section 6.3 of this report and in its Executive Summary. Similar confidence bounds were computed and added in the reports on nonfatal injuries. NHTSA's revised summary report on the "Relationship of Vehicle Weight to Fatality and Injury Risk in Model Year 1985-93 Passenger Cars and Light Trucks" shows all of these confidence bounds. In recognition of the possibility that the estimation procedure could have introduced additional sampling or nonsampling error, we have used 2-sigma and 3-sigma confidence bounds, rather than the 1.645-sigma bounds typically employed in NHTSA evaluations. Even with the 3-sigma bounds, it is clear that overall fatality risk increases as passenger cars get lighter. The effect of light-truck weight on overall societal fatality risk is not statistically significant.

EFFECT OF DRIVER AGE *Fatality risk per million vehicle years can be far more sensitive to driver age than vehicle weight. Although the analyses in the draft report attempted to control for driver age, TRB was concerned about the complex procedure used to develop the driver-age* *coefficients; moderate errors in those coefficients, or in the way that the model is formulated, could greatly distort the size-safety effects predicted by the model.*

RESPONSE While it is true that fatality risk decreases sharply for each year that drivers get older, from age 16 to about 35, risk again begins to increase sharply after age 45-55 in many types of crashes. Thus, the overrepresentation of young drivers in small cars is at least partially offset by the overrepresentation of old drivers in large cars. A principal revision of the draft report is the addition, in Section 6.4, of sensitivity tests on the coefficients for driver age and gender. The coefficients in the baseline model were changed to other values - ranging from zero to double the baseline values. These very large alterations in the driver-age coefficients did not dramatically change the model's estimate of the weight-safety effect: it stayed within the sampling error bounds of the baseline model.

DRIVER AGGRESSIVENESS; HORSEPOWER *TRB believes that more aggressive drivers tend to drive smaller cars (even after control for driver age), because small cars are more sporty and powerful. To that extent, the higher fatality rates for smaller cars reflect the characteristics of the drivers, not an inherently lower level of safety in the cars. TRB recommended re-running the analyses excluding make-models known to be associated with aggressive driving and risk-taking behavior; that would at least partially control for the driver aggressiveness factor.*

RESPONSE The "typical" small car is no longer a sports car. In today's vehicle fleet, the make-models usually associated with high performance, high horsepower, or aggressive driving are generally not small, but are typically of average or even slightly heavier-than-average weight. Exclusion of those models from the analyses can be expected to augment rather than dampen the observed weight-safety trend. This is precisely what happened in various sensitivity tests described in Section 6.5 of the revised report. However, the augmented weight-safety effects estimated in the sensitivity tests were still within the confidence bounds of the baseline estimate.

INDUCED EXPOSURE DATA BASE *TRB noted that the customary definition of "induced exposure" has been non-culpable crash involvements; the validity of those crashes as a measure of exposure has been established. TRB does not believe the draft report presented adequate justification for limiting induced exposure to <u>stationary</u> non-culpable crash involvements. The number of stationary involvements on rural, high-speed roads is quite limited, and that could add errors to analyses of fatality risk on those roads.*

RESPONSE TRB's critique of stationary non-culpable involvements, especially their infrequency on rural, high-speed roads, seems reasonable. It would have been better to use the customary definition of induced exposure. It should be noted, however, that the analyses using induced exposure (Chapters 2-4) are not the basis for the report's estimates and conclusions about the weight-safety effect. They only enter peripherally, as a basis for estimating the coefficients for driver age and gender. As shown in the sensitivity tests of Section 6.4, the weight-safety effects are not overly sensitive to changes in the driver age and gender coefficients.

MODEL FORMULATION AND VALIDATION *The draft report employs a model that assumes that the logarithm of the fatality rate has a linear relationship to vehicle weight, and to other control variables. TRB recommended, as a minimum, an examination of the residuals to test the validity of the assumption of linear fit.*

RESPONSE Section 6.6 examines the relationship between vehicle weight and the logarithm of the fatality rate (after adjusting for all other control variables), and it generally finds a very good linear fit, with little or no evidence of nonlinearity.

NON-UNIFORM WEIGHT REDUCTIONS *TRB believes that the effect of vehicle weight reduction on societal risk depends on how the reduction is distributed across the fleet: it is better to reduce the weight of large cars or light trucks than to reduce the weight of small cars. TRB recommended sensitivity tests to see what would happen if weight reductions were primarily applied to the larger cars, rather than fleetwide.*

RESPONSE The draft report already concluded that a weight reduction in light trucks would have little effect on societal risk, and might even result in a small benefit. The revised report includes, in Section 6.7, sensitivity tests estimating that the increase in societal risk would be smaller if the weight reduction were concentrated on the heaviest 20 percent of cars, rather than applied equally to all cars. However, the diminished weight-safety effect estimated in the sensitivity test was within the confidence bounds of the baseline estimate.