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The Relative Contribution of Truck Drivers and Passenger Vehicle Drivers to Truck-Passenger Vehicle Traffic Crashes

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16. Abstract

This study examined the relative contribution of truck and passenger vehicle drivers to truck-passenger vehicle traffic crashes. The data used covered fatal crashes, using UMTRI's Trucks Involved in Fatal Accidents file, and nonfatal crashes, using NHTSA's General Estimates System file. Analysis files were constructed for crashes involving one truck and one passenger vehicle, either a car, sport utility vehicle, passenger van, or pickup truck. For fatal crashes, the contribution of each driver was gauged primarily by examining the coding of driver-related factors. Driver-related factors were compared with a separate variable that records the relative movement and position of the vehicles prior to the crash. Certain crash configurations strongly suggest relative contribution to the occurrence of the crash. Accordingly, by examining the coding of driver-related factors by crash configuration, we were able to evaluate the reliability of the driver-related factors variable.

It appears that in fatal truck-passenger vehicle collisions, the passenger vehicle driver contributes more heavily to the crash than the truck driver. This finding is most firmly established in crashes where the physical nature of the collision suggests responsibility. For nonfatal truck-passenger vehicle crashes, the evidence is considerably less clear. Only the partial evidence of traffic violations is available in existing crash datasets. Nevertheless, it does appear in nonfatal truck-car crashes that truck drivers may contribute somewhat more than passenger vehicle drivers, though this conclusion is tentative.

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1. 0 Introduction

There is considerable interest in determining crash causation and identifying contributing factors in truck crashes. Heavy trucks are involved in about 300,000 police-reportable crashes each year, of which about 5,000 involve a fatality. About 85% of fatalities in truck crashes occur outside of the truck, either in other vehicles involved in the crash, or pedestrians and bicyclists. Given the disproportion in the distribution of fatalities and injuries between trucks and passenger vehicles involved in crashes, there is a perception that trucks are primarily responsible for these crashes. However, moving beyond perception to analysis of crash data is necessary to make progress in reducing the toll of deaths and injuries. Is the traffic safety problem involving heavy trucks primarily attributable to truck drivers or do passenger vehicle drivers contribute substantially?

A recent finding using data on fatal crashes seems to indicate that driving errors of passenger vehicle drivers contribute heavily to truck-passenger vehicle crashes. In two-vehicle, truck-passenger vehicle fatal crashes, some error on the part of the driver of the passenger vehicle is recorded significantly more often than the truck driver. Overall, truck drivers are coded with a driver-related factor in about 26.5% of the crashes, while passenger vehicle drivers are coded in over 80% of the crashes. Of the 5,453 two-vehicle, truck-passenger vehicle fatal crashes in 1994 and 1995, as identified in the Trucks Involved in Fatal Accidents (TIFA) file, fully 4,395 of the passenger vehicle drivers were assigned a driver-related factor, compared with 1,447 of the truck drivers. In 70.3% of the crashes, the passenger vehicle driver alone was coded with a driver-related factor, while in only 16.2% of the crashes, the truck driver alone was found to have committed some error.

Table 1
Driver-related factors coded for truck and passenger vehicle drivers
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

	Passenger vehicle driver							
	No factor		Factor coded		Unknown		Total	
Truck driver	N	%	N	%	N	%	N	%
No factor	95	1.7	3,831	70.3	30	0.6	3,956	72.5
Factor coded	884	16.2	542	9.9	21	0.4	1,447	26.5
Unknown	5	0.1	22	0.4	23	0.4	50	0.9
Total	984	18.0	4,395	80.6	74	1.4	5,453	100.0

Taken at face value, this table seems to indicate that passenger vehicle drivers contribute disproportionately to fatal crashes involving a truck and a passenger vehicle (a passenger car, passenger van, sport utility vehicle, pickup, or light truck in this analysis). That inference has been somewhat controversial. One explanation offered for the seeming disproportionate share of driver-related factors for passenger vehicle drivers is that typically the passenger vehicle driver is killed in a fatal, truck/passenger vehicle crash, while the truck driver survives. The hypothesis is that the truck driver is available to give "his side" of the crash and persuade the reporting police officer that the other driver was primarily at fault.

1. 1 Methodology

This study focuses on crashes involving one truck and one passenger vehicle. Such crashes cover about 60% of all fatal truck crashes and about two-thirds of all police-reportable traffic crashes involving a truck. Since the focus is on two-vehicle crashes, it does not address factors in single-vehicle truck crashes, which is where most truck driver fatalities occur. However, two-vehicle truck-passenger vehicle crashes do represent the large majority of truck crashes and can be used to evaluate the relative contribution of truck drivers and passenger vehicle drivers to the crash problem.

The approach here is primarily to analyze driver-related factors in light of information about how the crash occurred. The purpose is to test the validity of the coding of driver-related factors. Crash configuration data comes from an accident type variable coded in the Trucks Involved in Fatal Accidents (TIFA) file, compiled by the Center for National Truck Statistics at the University of Michigan Transportation Research Institute. A crash type variable records the relative position and movements of the vehicles leading up to the collision. In many crash types, the configuration of the crash is strongly related to the relative contribution of the two drivers. For example, in rear-end collisions, actions on the part of the striking vehicle typically (not always) lead more directly to the collision than actions of the struck vehicle.

Results from both fatal and nonfatal truck-passenger vehicle traffic crashes are considered. Among fatal crashes, the analysis considers driver-related factors coded for both vehicles and examines the coding of those factors in relation to the crash configuration. This analysis provides the most direct evaluation of traffic crashes, since the accident type variable provides an excellent description of what happened in the crash, and the driver-related factors variable provides the most detailed information available on driver actions related to the crash.

The analysis is supplemented by examining nonfatal truck-passenger vehicle crashes in a nationally representative sample file of all reportable traffic crashes. This file also includes the same accident type variable as the TIFA file, but information on driver-related factors is not available. Instead, traffic violations charged are used to the extent possible to evaluate the relative contribution of the truck and passenger vehicle drivers in traffic crashes. The use of traffic violations is problematic because a variety of factors influence whether a police officer will issue a citation. Not all contributing factors are chargeable and not all traffic violations are charged. The problem is further discussed in section 1.2.

Essentially, the approach taken here is to test whether the picture derived from the driver-related factors data is consistent with other information that can be argued to have independent confirmation. Truck-passenger vehicle crashes leave physical evidence, including marks on the road and points of impact on the vehicles. In head-ons, rear-ends, and sideswipes crashes, the configuration and location of the collision itself is a powerful clue to the relative contribution of the drivers involved. In the majority of truck-passenger vehicle fatal crashes, the crash configuration itself implies the relative contribution to the crash.

The results of this analysis show that the coding of driver-related factors is generally consistent with crash configuration. In crash types that strongly imply driver contribution, the driver of the striking vehicle or the vehicle that encroached on the other vehicle were given the majority of driver-related factors. Head-ons, rear-ends, and sideswipes account for a majority of passenger vehicle driver fatalities in truck-passenger vehicle collisions. The analysis found that in head-on crashes, the impact took place in the truck's lane over eight times as often as in the car's lane. In opposite direction sideswipes, which are similar to head-on crashes, the passenger vehicle encroached into the truck's lane six times as often as the reverse. And in

rearend fatal crashes, the passenger vehicle was the striking vehicle over five times as often as the truck. Thus, it is concluded that passenger vehicle drivers contribute disproportionately to truck-passenger vehicle crashes that result in a fatality.

Evaluating crashes of all severities is more difficult because traffic violations is the only tool available for nonfatal crashes. Overall, truck drivers were charged with a traffic violation more often than passenger vehicle drivers in truck-passenger vehicle collisions, though neither driver was charged in almost two-thirds of such crashes. However, crashes in which neither driver was injured account for almost all the difference between the violation rates.

1.2 Data

Two data sets are used in the analysis: the Trucks Involved in Fatal Accidents (TIFA) file from the University of Michigan Transportation Research Institute (UMTRI) and the General Estimates System (GES) file from the National Center for Statistics and Analysis (NCSA), of the National Highway Transportation Safety Administration (NHTSA). The TIFA file is the product of a survey of medium and heavy trucks involved in traffic crashes in which at least one fatality occurred. The file is based on the Fatal Accident Reporting System (the name through the 1996 data year; subsequently renamed the Fatality Analysis Reporting System file), from which medium and heavy trucks (class 3 and above gross vehicle weight rating (GVWR)) are extracted. A telephone survey supplements the FARS data with extensive physical detail about the configuration of the truck at the time of the fatal crash. Among other things, the phone survey ensures that all the vehicles in the file are indeed medium or heavy trucks. The crash type variable used in this analysis is part of the TIFA survey. The driver-related factors information comes from data recorded by FARS analysts in each state.

The GES file is a nationally representative sample of vehicles involved in police-reportable traffic crashes. Police reports of traffic crashes are sampled and an extensive list of data elements are coded from the police reports. There is no supplemental data collection. Weights are calculated to provide statistically valid national estimates of crash involvements.

Analytical files for this project were constructed from both the TIFA and GES files. The analytical files cover traffic crashes involving a truck and a passenger vehicle. The files are limited to crashes involving only two vehicles, one truck and one passenger vehicle.

The definition of a truck in this report is that of the TIFA file: a cargo-carrying vehicle with a GVWR over 10,000 pounds. Passenger vehicles include all automobiles, utility vehicles, light trucks, and pickup trucks. All these vehicles are typically used as passenger vehicles currently. Buses and motor homes are excluded.

The TIFA two-vehicle, truck-passenger vehicle file was built from the 1994 and 1995 TIFA files, the two most recent files that include the accident type variable. For those two years, there were 8,865 fatal truck crashes involving 9,441 trucks. Of the truck crashes, 5,453 involved exactly two vehicles, one of which was a truck and the other a passenger vehicle. (The analysis file excludes truck-truck two-vehicle crashes.) The two-vehicle analytical file covers 61.5% of all fatal truck crashes and 57.8% of all trucks involved in fatal truck crashes.

A similar file was constructed using the 1994 and 1995 GES files. This analytic file was also limited to two-vehicle traffic crashes in which one vehicle was a truck and the other was some other passenger motor

vehicle. There were an estimated 720,639 trucks involved in reportable traffic crashes in 1994 and 1995 and 691,111 total traffic crashes involving trucks. Of those, 462,531 trucks were involved in two-vehicle, truck-passenger vehicle traffic crashes, accounting for 64.2% of all trucks and 66.9% of all traffic crashes involving trucks.

The GES file has some characteristics that warrant further comment. GES includes two types of variables: normal variables that record data as coded from the police reports; and "imputed" variables where the information is derived from other variables when the normal variable is unknown on the police report. GES contains two variables that can be used to identify trucks: the body type variable and an imputed body type variable. In the imputed body type variable, body type is inferred from other variables when it is not identified directly on the police report. The procedure is documented in Shelton (1993).

In constructing the GES two-vehicle, truck-passenger vehicle crash file, trucks were identified using the nonimputed body type variable, rather than the imputed body type variable. Using the imputed body type variable resulted in an unreasonably large number of trucks coded with the "hit-and-run" traffic violation. About 9.5% of trucks (weighted) identified with the imputed body type variable are coded hit-and-run, while only 5.1% of trucks identified with the normal variable are coded hit-and-run. That 9.5% of trucks are hit-and-run vehicles seems unreasonably high. The 5.1% figure also is quite high, though obviously not as large as the other figure.

The high estimate for hit-and-run is produced by an interaction between the procedures for coding hit-and-run on the traffic violations variable and for imputing body type. According to the GES *Data Coding Manual* (1994, p. 96), hit-and-run is coded when "a motor vehicle in-transport, or its driver departs from the scene... If the police report indicates that the vehicle was involved in a collision which was investigated, but there is little or no information on that vehicle because of its departure prior to police arrival on-scene, then 'hit-and-run' is indicated." Hit-and-run thus becomes in practice a default code where there is little or no information on the police report, rather than recording hit-and-run explicitly indicated on the police report by the reporting officer. Since body type is imputed where it is unknown, that is, where there is little information on the police report, clearly using the imputed body type variable will result in a large number of hit-and-run traffic violations.

Shelton (1993, p. 20) indicates that imputed variables are primarily intended for overall size assessment questions. "More detailed analyses using imputed variables may lead to erroneous conclusions." The use of the imputed body type variable in the present analysis may overstate the incidence of hit-and-run traffic violations, and consequently the normal body type variable is more appropriate. However, since traffic violations are the primary information available in GES to evaluate the relative contribution of the truck and passenger vehicle driver to traffic crashes, clearly this decision can have a substantial impact on the outcome that part of the analysis.

1.3 The use of traffic violations to infer responsibility or contribution

The use of traffic violations to infer the contributions of drivers to the occurrence of traffic crashes is problematic. The purpose of charging a traffic violation is to enforce the law, not to assign causal responsibility. The user of police-reported crash data must be aware that reporting police officers are not data collectors in a research exercise. Traffic violations are not charged in all crashes. Traffic laws are not uniformly administered or enforced in the case of crashes. In fact, in almost two-thirds of all two-vehicle, truck-passenger vehicle crashes, neither driver is charged with a violation. Even in the more serious

crashes, as indicated by injury, almost 50% of such crashes result in no traffic violations charged to either driver.

Clearly, police officers exercise considerable discretion in issuing traffic citations. Officers decide to issue citations based on the seriousness of the offense, the existence of sufficient evidence to prove the offense in court, the intent of the violator, whether other enforcement action might be more effective, and a variety of other considerations (Ross, 1964; Ross, 1973; Traffic Institute, 1958). Evidently, in a large fraction of cases, officers choose not to issue a citation.

The Indiana Tri-level study (Treat, 1977) identified human factors as the probable case of 92.6% of crashes investigated. While not all the errors recorded in the Indiana study are chargeable offenses, most are certainly related to legal traffic offenses. Even if we do not take the 92.6% figure literally, there is a considerable gap with the proportion of traffic violations charged in the GES data.

Finally, large number of other or unknown violations limit the utility of the variable. For trucks, over 77% of involved drivers were not charged with any violation (table 17). Considering just the drivers who were charged, 55% were charged with an unspecified violation or one that was different from any of the specific violation codes available. An additional 23% were coded hit-and-run. Of the specific violation codes available in the GES file, 8.6% of truck drivers charged with a violation were cited for failure to yield and another 8.3% were cited for speeding.

1.4 Driver-related factors in FARS

Instructions in the FARS *Coding and Validation Manual* (FARS, 1996) are to "code information provided in the narrative by the investigating officer." Items coded here are primarily, but not always, factors that contributed to the crash. Typically, the police officer records in the narrative his understanding of how the crash occurred. The FARS analyst in each state then uses the police report and any other supporting materials to determine driver-related factors for each crash.

The use of driver-related factors is preferred to traffic violations as a means of understanding the relative contribution of different drivers to a crash. Charging a traffic violation has formal legal consequences. A police officer may have grounds for believing a driver committed a traffic error, but may not chose to charge a traffic offense because he lacks sufficient legal proof or for some other reason. However, the crash narrative allows the police officer to record his judgment on what happened, without committing him to proving it in a legal sense. Thus, the narrative allows a more full description of the factors that contributed to the crash.

Some items recorded in the driver-related factors are not factors judged to have contributed to the crash. These include codes for a number of "devices in vehicle with potential for distraction," including cell phone, fax machine, computer, on-board navigation system, two-way radio, and headup display. These codes simply record the existence of such devices, not that the driver was in fact distracted by them. Coding instructions for the variable indicate that if the driver was distracted by these (or any other) devices, the appropriate code is "inattentive." In addition, there are a set of miscellaneous codes (carrying hazardous cargo improperly, hit-and-run, nontraffic violation, other nonmoving violation) that also do not directly address driving errors that contributed to the crash. The codes that are not germane to crash causation amount only to about 5% of the all the factors coded, including "none," but are nevertheless included in the analysis.

2.0 Results of the analysis of fatal two-vehicle collisions

2.1 Driver history

This section begins with a presentation of some driving history information about the two drivers, truck and passenger vehicle, involved in fatal two-vehicle crashes in 1994 and 1995. This information is provided by FARS and is collected from the driver's record. It is unknown how complete driver records are, or the extent to which records from multiple states might be collected together. If driver records do not reflect crashes, violations, suspensions, and so on that occurred in multiple states, it is likely that these problems are underrepresented to a greater extent on truck drivers' records, since truck drivers typically operate in many states. Similarly, problems that are to a large extent a function of exposure, like crashes, speeding violations, and other moving violations, are more likely for truck drivers than other drivers, because they drive many more miles annually than passenger vehicle drivers.

Almost 75% of truck drivers had no previous reported crashes prior to the current one, compared with almost 80% of the passenger vehicle drivers involved (table 2). Overall, the distributions are comparable, with truck drivers slightly more likely to have been involved in a previous crash.

Table 2
Previous accidents of truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Previous accidents	Truck driver		Passenger vehicle driver	
	N	%	N	%
0	4,058	74.4	4,343	79.6
1	888	16.3	747	13.7
2	179	3.3	103	1.9
3	29	0.5	19	0.3
4	9	0.2	6	0.1
5 or more	2	0.0	4	0.1
Not reported	32	0.6	67	1.2
Unknown	256	4.7	164	3.0
Total	5,453	100.0	5,453	100.0

Table 3 shows the previous license suspensions recorded by truck and passenger vehicle drivers in the two-vehicle crashes. The truck drivers involved were slightly more likely to have had no previous suspensions than the other drivers, but otherwise the distributions are similar. Almost one percent of passenger vehicle drivers had five or more suspensions. Two had ten suspensions and another two passenger vehicle drivers had eleven previous suspensions. Among the truck drivers, one had eleven previous license suspensions and two had seven previous suspensions.

Table 3
Previous suspensions of truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Previous suspensions	Truck driver		Passenger vehicle driver	
	N	%	N	%
0	4,814	88.3	4,688	86.0
1	246	4.5	315	5.8
2	69	1.3	141	2.6
3	33	0.6	62	1.1
4	16	0.3	33	0.6
5 or more	18	0.3	50	0.9
Unknown	257	4.7	164	3.0
Total	5,453	100.0	5,453	100.0

The truck drivers involved in two-vehicle, truck-passenger vehicle fatal crashes were more likely to have had previous speeding convictions than the passenger vehicle driver in the crash (table 4). Fully 24.5% of truck drivers had one or two speeding convictions, compared with 17.4% of passenger vehicle drivers. Only about 67% of truck drivers had no previous speeding convictions, compared with almost 78% of the passenger vehicle drivers.

Table 4
Previous speeding convictions
of truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Previous speeding convictions	Truck driver		Passenger vehicle driver	
	N	%	N	%
0	3,660	67.1	4,240	77.8
1	973	17.8	741	13.6
2	362	6.6	207	3.8
3	106	1.9	59	1.1
4	58	1.1	22	0.4
5 or more	37	0.7	20	0.4
Unknown	257	4.7	164	3.0
Total	5,453	100.0	5,453	100.0

The truck drivers also tended to have somewhat more "other previous moving "violations than passenger vehicle drivers, as shown in table 5. Over 17% of truck drivers had one or two moving violations, compared with 11.9% of the passenger vehicle drivers. Over 84% of passenger vehicle drivers in fatal two-vehicle crashes had no recorded previous moving violations, compared with 76% of the truck drivers.

Table 5
Other previous moving violations
of truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Other previous moving violations	Truck driver		Passenger vehicle driver	
	N	%	N	%
0	4,148	76.1	4,590	84.2
1	716	13.1	541	9.9
2	232	4.3	110	2.0
3	67	1.2	22	0.4
4	24	0.4	15	0.3
5 or more	9	0.2	11	0.2
Unknown	257	4.7	164	3.0
Total	5,453	100.0	5,453	100.0

The data on previous driving-while-intoxicated (DWI) convictions indicates a higher involvement for passenger vehicle drivers than truck drivers (table 6). For both sets of drivers, a large majority had no previous convictions for DWI. Almost 93% of the passenger vehicle drivers and over 94% of the truck drivers had no previous DWI conviction. However, 4.2% of passenger vehicle drivers had at least one previous DWI, while only 1.1% of the truck drivers had one or two previous DWI convictions. None of the truck drivers had three previous DWI's, while one of the passenger vehicle drivers had three previous DWI's.

Table 6
Previous DWI convictions of truck and
passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Previous DWI	Truck driver		Passenger vehicle driver	
	N	%	N	%
0	5,137	94.2	5,061	92.8
1	51	0.9	185	3.4
2	8	0.1	42	0.8
3	0	0.0	1	0.0
Unknown	257	4.7	164	3.0
Total	5,453	100.0	5,453	100.0

The tables thus far have shown the previous records of the drivers, truck and passenger vehicle, involved in two-vehicle fatal collisions. Overall, the records of the involved parties are reasonably similar. Somewhat higher percentages of truck drivers had previous crashes, speeding, and other moving violations, while more passenger vehicle drivers had previous DWI convictions and license suspensions. It should be noted that, for each of the items considered, a large majority of both groups had no previous involvement. Even in the case of something as (relatively) minor as a previous speeding conviction, 67% of truck drivers and 77% of passenger vehicle drivers had no previous involvement (table 4).

2.2 Violations

Considering the current traffic crash, passenger vehicle drivers show significantly higher involvement with alcohol. Over 16% of passenger vehicle drivers in fatal truck-passenger vehicle crashes had been drinking (table 7). This percentage compares with only 1.4% of the truck drivers. Thus, over eleven times as many passenger vehicle drivers as truck drivers had been drinking prior to the fatal collision. Note the relatively high percentage of "not reported" for both truck drivers and passenger vehicle drivers. Also, about 10% of the cases are unknown for passenger vehicle drivers, and 2.1% of the cases are unknown for truck drivers. However, even if *all* the unknown truck drivers had been drinking, the percentage would still be substantially less than the percentage of drinking passenger vehicle drivers.

Table 7
Driver drinking, truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Driver drinking	Truck driver		Passenger vehicle driver	
	N	%	N	%
No	4,730	86.7	3,479	63.8
Drinking	78	1.4	885	16.2
Not reported	529	9.7	547	10.0
Unknown	116	2.1	542	9.9
Total	5,453	100.0	5,453	100.0

Drug involvement is also higher for the passenger vehicle drivers in two-vehicle, truck-passenger vehicle fatal involvements, though for both populations involvement is relatively low and not as readily detected. Sixty-nine of the passenger vehicle drivers had been using drugs, compared with only 17 of the truck drivers. Note that drug used was not reported, however, for about two-thirds of both groups.

Table 8
Drug involvement, truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Drug involvement	Truck driver		Passenger vehicle driver	
	N	%	N	%
No drugs	1,499	27.5	1,186	21.7
Drugs	17	0.3	69	1.3
Not reported	3,678	67.4	3,553	65.2
Unknown	259	4.7	645	11.8
Total	5,453	100.0	5,453	100.0

The final tables in this section deal with the traffic violations charged to each driver. Some of the problems in interpreting traffic violations are discussed above. Suffice it to say here that charging traffic violations in fatal collisions is highly problematic. Fatally injured drivers are typically not charged, as filing such charges is pointless. No traffic violations at all were charged in over 77% of the two-vehicle, truck-passenger vehicle fatal involvements (table 9). In 10.6% of the crashes, the truck driver only was charged,

and in 4.9% of the cases the passenger vehicle driver only was charged. However, charging is clearly related to survival. Fatally injured passenger vehicle drivers were charged with a traffic violation in only 2.1% of the crashes and fatally injured truck drivers were charged in only 5.6% of such crashes. However, note that where neither driver was killed,[1] the passenger vehicle driver was charged at a higher rate than the truck driver. Neither was charged 48.9% of the time, 15.5% of the truck drivers were charged and 23.4% of the passenger vehicle drivers were charged.

Table 9
Traffic violations charged to truck and passenger vehicle driver by fatal injury
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

	Driver fatal injury									
Violation	Neither		Truck only		Pass. veh. only		Both		Total	
charged	N	%	N	%	N	%	N	%	N	%
None charged	386	48.9	63	70.0	3,750	82.4	21	91.3	4,220	77.4
Truck only	100	12.7	3	3.3	475	10.4	2	8.7	580	10.6
Pass. veh.	163	20.7	18	20.0	86	1.9	0	0.0	267	4.9
Both	22	2.8	2	2.2	8	0.2	0	0.0	32	0.6
Unknown	118	15.0	4	4.4	232	5.1	0	0.0	354	6.5
Total	789	100.0	90	100.0	4,551	100.0	23	100.0	5,453	100.00

Table 10 shows the distribution of traffic violations charged in fatal, truck-passenger vehicle collisions, though in light of the previous discussion, the table does not shed much light either on the relative contribution of truck and passenger vehicle drivers to fatal collisions or on the type of errors committed by drivers to fatal collisions. However, it is worth noting that the vast majority of both drivers are not charged with any traffic violations in fatal, two-vehicle collisions. Also, note that passenger vehicle drivers are charged at twice the rate as truck drivers with alcohol or drug-related violations, while truck drivers are charged with speeding or reckless driving at a higher rate than passenger vehicle drivers. It is emphasized that charged violations are poor evidence of the actual rate of driving errors.

[1] The fatality occurred most often to a passenger or to some other person in the crash.

Table 10
Violations charged, truck and passenger vehicle driver
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Violation charged	Truck driver		Passenger vehicle driver	
	N	%	N	%
None	4,568	83.8	5,031	92.3
Alcohol	30	0.6	59	1.1
Speeding	46	0.8	20	0.4
Alcohol/drugs and speeding	6	0.1	17	0.3
Reckless driving	18	0.3	8	0.1
Suspended/ revoked license	11	0.2	8	0.1
Other moving	374	6.9	180	3.3
Non-moving	105	1.9	12	0.2
Other or unknown type	33	0.6	1	0.0
Unknown	262	4.8	117	2.1
Total	5,453	100.0	5,453	100.0

2.3 Driver-related factors

FARS analysts code up to three driver-related factors, recording driver actions or conditions that contributed to the collision. As discussed above, not all factors record events that contributed to the crash; driving with a suspended license, for example, can hardly have contributed to a particular collision. However, such codes amount only to about 5% of all driver-related factors and are included in the analysis.

Table 1 above provides the fundamental distribution of driver-related factors for both drivers in fatal truck-passenger vehicle collisions. Overall, FARS analysts identified at least one driver-related factor for truck drivers in about 26.5% of the crashes, while passenger vehicle drivers are coded with at least one factor in 80.6% of the crashes. Of the 5,453 two-vehicle, truck-passenger vehicle fatal crashes in 1994 and 1995, as identified in the TIFA file, fully 4,395 of the passenger vehicle drivers were assigned a driver-related factor, compared with 1,447 of the truck drivers. In 70.3% of the crashes, the passenger vehicle driver alone was coded with a driver-related factor, while in only 16.2% of the crashes, the truck driver alone was found to have committed some error.

One explanation for the preponderance of driver-related factors assigned to passenger vehicle drivers is that truck drivers more often survive the collision, while passenger vehicle drivers are killed. The surviving driver influences the reporting police officer's report, resulting in blame assigned incorrectly to the deceased driver. Table 11 shows the coding of driver-related factors by whether a driver was fatally injured. In cases where only the driver of the passenger vehicle was killed in the collision, 81.9% of the passenger vehicle drivers were assigned at least one driver-related factor (factor coded for "passenger vehicle only" or "both"), while only 24.1% of truck drivers were assigned a factor. In collisions where only the truck driver was killed, 57.7% of truck drivers were assigned at least one factor, compared with 46.7% of the surviving passenger vehicle drivers.

Table 11
Driver-related factors by driver fatal injury
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Factor coded	Driver fatal injury: Neither N	%	Truck only N	%	Passenger vehicle only N	%	Both N	%	Total N	%
Neither	30	3.8	4	4.4	61	1.3	0	0.0	95	1.7
Truck only	158	20.0	39	43.3	682	15.0	5	21.7	884	16.2
Pass. veh. only	471	59.7	29	32.2	3,315	72.8	16	69.6	3,831	70.3
Both	114	14.4	13	14.4	413	9.1	2	8.7	542	9.9
Unknown	16	2.0	5	5.6	80	1.8	0	0.0	101	1.9
Total	789	100.0	90	100.0	4,551	100.0	23	100.0	5,453	100.0

However, the "surviving driver" hypothesis is too simple. Where neither the truck driver nor the passenger vehicle driver is killed, the passenger vehicle driver is assigned a driver-related factor in 74.1% of the collisions while the truck driver is assigned a factor in 34.5% of the cases. The passenger vehicle driver is assigned a factor at about twice the rate as the truck driver. If driver survival explained the overall preponderance of driver factors for passenger vehicle drivers, one would expect factors to be about equal where both survived. One explanation might be that in fatal collisions where both drivers survived, the passenger vehicle driver was so badly injured, he was not able to defend himself on the spot, thus resulting in blame assigned unfairly to him. This possibility was not explored.

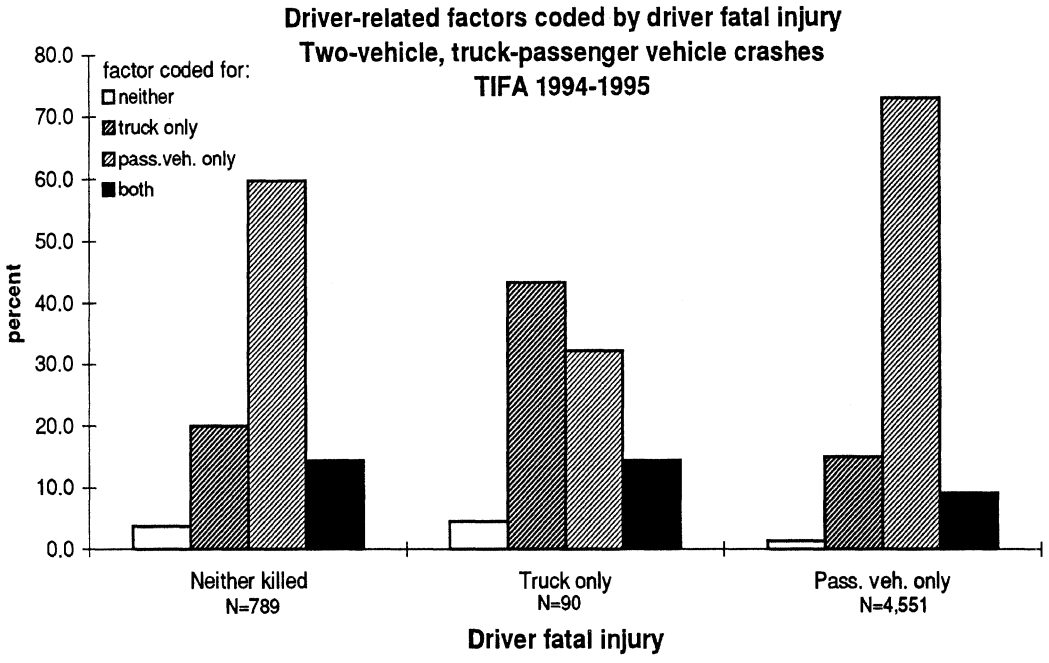

Figure 1

2.4 Driver-related factors and crash type

Another possibility, however, is that the preponderance of driver-related factors assigned to passenger vehicle drivers is correct, and that in the types of two-vehicle, truck-passenger vehicle collisions that result in a fatality, a contributing error is more likely to have been committed by the passenger vehicle driver. The problem in testing that hypothesis is finding evidence that what the officer recorded (and what the FARS analyst used to assign driver-related factors) has some basis in fact.

The evidence used here to help understand the coding of driver-related factors comes from the diagrams and narrative recorded on the police report. On most police reports, the reporting officer has drawn a diagram of the events of the collision, along with a brief explanation. Now, at this point, the argument appears circular: the diagram and narrative is used to test the accuracy of the coding of driver-related factors, which are in turn coded from the crash diagram and narrative! One might show that the two are consistent, but how can one conclude anything as to accuracy?

The answer proposed stems from the fact that truck collisions are extremely energetic events that leave physical evidence. Head-on collisions leave gouges in the road showing the point of impact. The juxtaposition of the vehicles after the collision in combination with the location of damage can explain how the collision occurred. Accident-reconstructionists can reconstruct the events of a crash with high confidence using the physical evidence on the vehicles and roadway, independent of the recollections of the participants. All police officers are not trained as reconstructionists, but many have had extensive experience with traffic crashes and some crash types are simply unmistakable. Moreover, many police reports include witness statements and, at least in my experience, police officers typically are skeptical of the unsupported statements of interested parties.

In any case, the approach here is to examine driver-related factors coded with respect to the crash configuration of two-vehicle, truck-passenger vehicle fatal collisions. In some types of fatal crashes, the location of the impact or the relative position of the vehicles strongly suggests that one party contributed more heavily than the other. The primary examples here are rear-end and head-on collisions. In a rear-end collision, it is highly likely that the striking vehicle, to the extent that *driver* error is to blame, contributed more heavily than the struck vehicle. Clearly there are instances to the contrary, but it seems a reasonable working assumption. The other example is the location of head-on collisions. It is more likely that the driving error, again to the extent to which *driving* errors contributed, was committed by the driver of the vehicle that crossed the center line into the other lane, rather than the vehicle that remained in its own lane. Once again, this is an assumption, but a reasonable one.

The TIFA files for 1994 and 1995 include an accident type variable which records the relative motions and positions of the vehicles prior to the first harmful event. Almost 100 different events can be captured by the variable. For the purposes of this analysis, several specific crash configurations have been aggregated to form more general types. For example, cases where the truck rear-ended a stopped, slower, or slowing lead vehicle have been combined to form the "rearend, truck striking" category.

The aggregation is done to create meaningful categories that, to the extent possible, shed light on the relative driver contribution to the collision. Rear-end collisions are classified as striking or struck, for example. Sideswipes are divided into same direction and opposite direction, and by whether the truck encroached on the passenger vehicle or the passenger vehicle encroached into the truck's lane. Head-on collisions are also aggregated into those occurring in the truck's lane and those that occurred in the other

vehicle's lane. The other collision types do not directly implicate one vehicle or the other because right-of-way is not reflected in the crash configuration. For example, in turning-across-path collisions, it is not clear which vehicle had the right of way. A vehicle in a left turn flare with a lead green light could turn across the path of another vehicle, and the turning vehicle would have the right-of-way. Similarly, in the straight-path collisions, it is not clear which vehicle violated the right of way by running a stop sign or signal, et cetera.

The types of collisions in which passenger vehicle drivers are killed in two-vehicle, truck-passenger vehicle collisions, are quite different from collisions fatal to the truck driver. Table 12 shows the distribution of crash configurations fatal to the truck driver and fatal to the passenger vehicle driver. Also shown are all fatal truck-passenger vehicle crashes. The largest categories of crashes fatal to truck drivers are the "other" crash configuration and the rearend configuration, with the truck as the striking vehicle. The "other" type includes configurations that do not fit into any of the specific types shown. Rear-ends where the truck was the striking vehicle account for 10.6% of truck driver fatalities in two vehicle, truck-passenger vehicle fatal collisions, and same direction sideswipes, with the truck encroaching into the other vehicle's lane, account for 10.6%. Probably the most important thing to note is that, in two years, only 113 truck drivers were killed in two-vehicle collisions with a passenger vehicle. Single vehicle crashes account for most truck driver fatalities.

Table 12
Driver fatality for truck and passenger vehicle driver by accident type
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Accident type	Fatal to passenger vehicle driver		Fatal to truck driver		All fatal passenger vehicle-truck crashes	
	N	%	N	%	N	%
Rearend, truck striking	103	2.3	12	10.6	175	3.2
Rear end, passenger vehicle striking	534	11.7	4	3.5	649	11.9
Sideswipe, same direction, truck encroach	26	0.6	12	10.6	49	0.9
Sideswipe, same direction, passenger vehicle encroach	83	1.8	8	7.1	120	2.2
Head-on in passenger vehicle's lane	138	3.0	4	3.5	156	2.9
Head-on in truck's lane	1,157	25.3	11	9.7	1,236	22.7
Sideswipe opposite direction truck encroach	60	1.3	1	0.9	67	1.2
Sideswipe opposite direction, passenger vehicle encroach	356	7.8	4	3.5	386	7.1
Truck turned across path	174	3.8	0	0.0	223	4.1
Passenger vehicle turned across path	410	9.0	12	10.6	496	9.1
Other turning-related	22	0.5	0	0.0	32	0.6
Straight path, truck into passenger vehicle	770	16.8	3	2.7	925	17.0
Straight path, passenger vehicle into truck	254	5.6	6	5.3	296	5.4
Truck backed into passenger vehicle	6	0.1	0	0.0	8	0.1
Other backed into truck	0	0.0	0	0.0	2	0.0
Other crash type	361	7.9	35	31.0	506	9.3
Unknown crash type	120	2.6	1	0.9	127	2.3
Total	4,574	100.0	113	100.0	5,453	100.0

Two-vehicle collisions fatal to the passenger vehicle driver fall into quite different crash configurations. The largest single category is a head-on, where the passenger vehicle came across the center line into the

truck's lane, with 25.3% of passenger vehicle driver fatalities. If the cases where the truck crossed the center line into the passenger vehicle's lane are included, head-ons account for 28.3% of passenger vehicle driver fatalities in two-vehicle collisions with trucks. The next largest category is the case where both vehicles are going straight, crossing paths (as at an intersection) and the truck strikes the passenger vehicle. Almost 17% of cases fall into that category. Crossing paths, both vehicles going straight accounts for 22.4% of passenger vehicle driver fatalities. Rear-ends, where the passenger vehicle strikes the truck in the rear, account for almost 12% of passenger vehicle fatalities, over five times as many as where the truck strikes the passenger vehicle.

Head-ons, rear-ends, and sideswipes are all crash configurations where the configuration of the collision itself is a powerful clue to the relative contribution of the drivers involved. Together these crash configurations account for 53.7% of passenger vehicle driver fatalities and 52.0% of all fatal two-vehicle, truck-passenger vehicle crashes. These crash configurations are all ones where there is physical evidence for the nature of the collision. The reporting officer does not have to rely on the word of the participants to see where a head-on collision occurred, or who hit whom in the case of a rear end. For all of these collision types, one would expect to see more driver-related factors coded for the driver of the striking vehicle or the driver who encroached into the other vehicle's lane. In the remaining crash configurations, contribution to the crash is less clear from the configuration of the collision. We might also expect that the driver factors are more evenly distributed between the two drivers.

Table 13 shows how driver-related factors are distributed between the truck and passenger vehicle driver for each crash configuration. The distribution of driver-related factors within crash configurations is consistent with expectations. For example, in the case of rearend crashes with the truck as the striking vehicle, over 66% of truck drivers were coded with at least one driver-related factor ("truck only" column plus "both"), compared with 37.7% of passenger vehicle drivers. In the case of rearends where the passenger vehicle is the striking vehicle, 91.2% of the passenger vehicle drivers were assigned a factor, compared with 19.7% of the truck drivers they struck. Head-on collisions in the truck's lane is the largest single category in the crash configuration classification adopted here. This category accounts for 22.7% of all fatal, truck-passenger vehicle collisions. The passenger vehicle driver in these collisions, who crossed the centerline into the truck's path, are assigned a driver-related factor in 98.0% of the crashes, compared with 6.9% of the truck drivers.

Table 13
Driver-related factor coded by accident type
Truck-passenger vehicle fatal crashes
TIFA 1994-1995

	Driver-related factor coded											
	Neither		Truck driver only		Pass. veh. driver only		Both		Unknown		Total	
Accident type	N	%	N	%	N	%	N	%	N	%	N	%
Rearend, truck striking	6	3.4	93	53.1	43	24.6	23	13.1	10	5.7	175	100.0
Rear end, passenger vehicle striking	7	1.1	27	4.2	491	75.7	101	15.6	23	3.5	649	100.0
Sideswipe, same dir, truck encroach	0	0.0	32	65.3	8	16.3	7	14.3	2	4.1	49	100.0
Sideswipe, same dir, passenger vehicle encroach	2	1.7	2	1.7	106	88.3	10	8.3	0	0.0	120	100.0
Head-on in passenger vehicle's lane	4	2.6	130	83.3	8	5.1	14	9.0	0	0.0	156	100.0
Head-on in truck's lane	3	0.2	17	1.4	1143	92.5	68	5.5	5	0.4	1,236	100.0
Sideswipe opposite dir truck encroach	0	0.0	46	68.7	14	20.9	2	3.0	5	7.5	67	100.0
Sideswipe opposite dir, passenger vehicle encroach	4	1.0	3	0.8	353	91.5	24	6.2	2	0.5	386	100.0
Truck turned across path	6	2.7	99	44.4	82	36.8	26	11.7	10	4.5	223	100.0
Passenger vehicle turned across path	0	0.0	35	7.1	395	79.6	62	12.5	4	0.8	496	100.0
Other turning-related	0	0.0	14	43.8	14	43.8	2	6.3	2	6.3	32	100.0
Straight path, truck into passenger vehicle	8	0.9	125	13.5	704	76.1	79	8.5	9	1.0	925	100.0
Straight path, passenger vehicle into truck	2	0.7	65	22.0	188	63.5	36	12.2	5	1.7	296	100.0
Truck backed into passenger vehicle	0	0.0	6	75.0	0	0.0	2	25.0	0	0.0	8	100.0
Other backed into truck	0	0.0	0	0.0	2	100.0	0	0.0	0	0.0	2	100.0
Other crash type	52	10.3	175	34.6	176	34.8	80	15.8	23	4.5	506	100.0
Unknown crash type	1	0.8	15	11.8	104	81.9	6	4.7	1	0.8	127	100.0
Total	95	1.7	884	16.2	3831	70.3	542	9.9	101	1.9	5,453	100.0

The argument that reporting officers' narratives and diagrams accurately depict crash configurations is probably strongest for head-on and rear-end crashes. In these crash types the physical evidence is unmistakable. Similarly, the argument is also strongest that the crash configuration itself provides an indicator of which driver contributed more to the collision. For sideswipes, the physical evidence is not necessarily as strong. For example, a same-direction sideswipe in which the truck moved into a passenger vehicle may not leave much evidence as to where the sideswipe occurred. On the other hand, an opposite direction sideswipe is a near-head-on collision and is therefore more likely to leave physical evidence of the point of impact. Finally, in the remaining collision types, without knowing which vehicle had the right-of-way, it is impossible to infer responsibility from the crash configuration.

Table 14 sorts the coding of driver-related factors into three categories: (1) head-ons and rear-ends, which provide good physical evidence for the accuracy of driver-related factor coding; (2) sideswipes, where the physical evidence is less strong for which vehicle encroached, but if the encroaching vehicle is correctly identified, contribution to the crash in general can be identified; and (3) all other crashes, for which we essentially have to take the reporting officer's word. Sorted this way, we can evaluate how driver-related factors are distributed between the truck and passenger vehicle driver. In the first category, passenger vehicle drivers are assigned related factors in about 85.3% of the cases, the truck driver in 21.3%. The

difference between factors coded for the passenger vehicle and truck driver in this subset is actually a bit more than the difference for all two-vehicle crashes, as shown in table 1. This is the subset for which the surviving driver would have the most difficult time influencing the police officer and in which the configuration of the collision itself strongly implies contribution (see table 13). In addition the distribution of related factors is about the same or more strongly in favor of the truck driver than crashes overall. The interpretation for sideswipes is similar. Table 14 in combination with table 13 lends credibility to the overall assessment of driver-related factors in two-vehicle, truck-passenger vehicle fatal involvements.

Table 14
Driver-related factor coded by accident type
Two-vehicle, truck-passenger vehicle fatal crashes
TIFA 1994-1995

Accident type	Driver-related factor coded: Neither		Truck driver only		Pass. veh. driver only		Both		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Rearend and head-on	20	0.9	267	12.0	1,685	76.0	206	9.3	38	1.7	2,216	100.0
Sideswipes	6	1.0	83	13.3	481	77.3	43	6.9	9	1.4	622	100.0
All else	68	2.7	519	20.9	1,561	62.7	287	11.5	53	2.1	2,488	100.0
Unknown	1	0.8	15	11.8	104	81.9	6	4.7	1	0.8	127	100.0
Total	95	1.7	884	16.2	3,831	70.3	542	9.9	101	1.9	5,453	100.0

A final means of validation is to examine the driver-related factors for each driver and each crash configuration. The tables are provided in the appendix. They are too lengthy and numerous to discuss here. Nevertheless, suffice it to say that the coding of driver-related factors, that is, the actual factors assigned, are in general quite consistent with the crash configurations into which the crashes fall. This consistency, particularly where the crash configuration is likely to be based on physical evidence, provides grounds for regarding the coding of factors as accurate.

Thus there are strong grounds for regarding the coding of driver-related factors in FARS as generally accurate, which implies that passenger vehicle drivers contribute more to truck-passenger vehicle fatal crashes than trucks do. But it is possible that passenger vehicle drivers commit more of the driving errors in fatal crashes because the errors of the passenger vehicle driver are more likely to lead to a fatality than the other way around. For example, a fatality may be more likely to occur if a passenger vehicle strikes the rear of a truck, rather than the truck striking the rear of a passenger vehicle. This could be true because there is less crush space available to the passenger vehicle driver when he strikes the rear of a truck than if the truck strikes the passenger vehicle, while the driver's seat may provide some additional protection when a vehicle is rear-ended. Accordingly, the disproportion of passenger vehicle driver errors in fatal crashes may be in a sense related to the fact that a fatality occurred, rather than that they are more culpable.

The probability of fatality by crash configuration can be calculated using GES and TIFA data. The GES accident type variable provided the model for the TIFA accident type variable, so the two are consistent. In table 15, risk of fatality given an injury is calculated for each crash configuration. Probability of fatality is calculated as the percentage of fatal crashes, using TIFA data, given a crash in which an injury or fatality occurred. Injury crashes are estimated using the GES data. Pairs of crash types are bounded with light lines.

Table 15
Probability of fatality given injury by accident type
Truck-passenger vehicle crashes
1994-1995 GES, 1994-1995 TIFA

Accident type	N	Probability of fatality
Rearend, truck striking	15,038	1.2
Rear end, passenger vehicle striking	14,943	4.3
Sideswipe, same dir, truck encroach	8,450	0.6
Sideswipe, same dir, passenger vehicle encroach	7,590	1.6
Head-on in passenger vehicle's lane	520	30.0
Head-on in truck's lane	2,380	51.9
Sideswipe opposite dir, truck encroach	3,156	2.1
Sideswipe opposite dir, passenger vehicle encroach	5,593	6.9
Truck turned across path	15,019	1.5
Passenger vehicle turned across path	9,135	5.4
Other turning-related	2,498	1.3
Straight path, truck into passenger vehicle	7,057	13.1
Straight path, passenger vehicle into truck	4,932	6.0
Truck backed into passenger vehicle	2,447	0.3
Other backed into truck	86	2.3
Other crash type	8,370	6.0
Unknown crash type	642	19.8
Total	107,855	5.1

Overall the probability of fatality given at least some injury in a truck-passenger vehicle crash is about 5.1%. Clearly there are large differences in the probability of fatality across the different crash types. Note that there is about the same number of rear-ends (with an injury or fatality) where the truck struck the passenger vehicle as the reverse, but the risk of a fatality is over three times as high (4.3% to 1.2%) when the passenger vehicle is the striking vehicle. Similarly, in opposite direction sideswipes, the passenger vehicle encroaching on the truck is almost three times more likely to result in a fatality than the reverse. Even for head-on collisions, the crash configuration in which the passenger vehicle came into the truck's lane has a higher probability of fatality. In crashes where both vehicles were going straight, cases where the truck struck the passenger vehicle have about twice the probability of a fatal injury as the reverse. Similarly, where one vehicle is turning across the other vehicle's path, the risk of fatality is about three times as great when the passenger vehicle is turning. In each case, the passenger vehicle was struck broadside essentially and the structure of the vehicle, if the impact occurs on the driver's side, offers very little protection.

Taking as a group the crashes (head-ons, rear-ends and sideswipes) where the crash configuration itself suggests responsibility, passenger vehicle driver errors are much more likely to result in a fatality than truck driver errors. In the following table, crashes where the passenger vehicle driver is at fault includes rear-ends where the passenger vehicle is the striking vehicle, along with head-ons and sideswipe crashes

where the passenger vehicle encroached on the truck. The complement crashes are combined as truck driver fault.

Table 16
Probability of fatality given injury by driver fault
selected crash types only
Truck-passenger vehicle crashes
1994-1995 GES, 1994-1995 TIFA

Fault	N	Probability of fatality
Truck driver	27,164	1.6
Passenger vehicle driver	30,506	7.8
Total	57,669	4.9

Note that crash configurations that suggest the passenger vehicle driver primarily contributed have a much higher probability of fatality than those crash configurations that suggest the truck driver was responsible. But while there is a ready explanation for differences in the probability of fatality for rear-end crashes, the relation of fault to probability of fatality is not at all clear for the remaining crash types included in the table. For rear-ends, there is a physical mechanism to explain why passenger vehicle driver errors has a higher probability of fatality than truck driver errors. When passenger vehicle driver errors result in the passenger vehicle rear-ending a truck, with less crush space for the driver, frequent underride, and no protection from the driver's seat. But for the other crash types in the group, it is hard to imagine a physical mechanism to explain why, for example, a sideswipe with the passenger vehicle as the encroaching party should have a higher probability of fatality than the truck encroaching on the passenger vehicle's lane. Or why a head-on in the truck's lane should have a higher proportion of fatalities than a head-on in the passenger vehicle's lane. Possibly there is some event in the crashes, not captured by the accident type variable, that explains the difference in fatality risk.

However, for the remaining crash types, there is not enough information to determine if errors of passenger vehicle drivers are more likely than those of truck drivers to lead to a fatal crash. The nature of the collision does not itself suggest contribution. Attributing fault in the collision requires more information, such as which vehicle had the right-of-way. So while the case of rear-ends suggests that the overrepresentation of passenger vehicle drivers as at fault might be because the errors of the passenger vehicle driver are more likely to lead to a fatality, for the other crash types there is no clear explanation. And there remains the fact that 88% of head-on collisions, which account for about 25% of fatal truck-passenger vehicle crashes, occur in the truck's lane.

3.0 Results of the analysis of truck-passenger vehicle collisions of all severities

The following material is derived from an analysis of data from the General Estimates System file. While the previous section was limited to fatal truck-passenger vehicle crashes, GES covers all police-reportable traffic crashes. Accordingly, the material covers crashes of all severities. GES does not include any information similar to the driver-related factors variables in FARS. The closest analog is data on traffic violations charged. Cautions on using traffic violations are discussed in section 1.2.

3.1 Traffic violations in two-vehicle, truck-passenger vehicle crashes

Traffic violations are typically not charged in two-vehicle, truck-passenger vehicle collisions. As table 17 indicates, almost 78% of involved truck drivers and 83% of passenger vehicle drivers were not charged with any violation. In addition, large numbers of other or unknown violations limit the utility of the variable. Considering just the drivers who were charged, 55% were charged with an unspecified violation or one that was different from any of the specific violation codes available. An additional 23% were coded hit-and-run. Of the specific violation codes available in the GES file, 8.6% of truck drivers charged with a violation were cited for failure to yield and another 8.3% were cited for speeding.

Table 17
Traffic violations in two-vehicle, truck-passenger vehicle crashes
1994-1995 GES

	Truck driver		Passenger vehicle driver	
Violation charged	**N**	**%**	**N**	**%**
None	375,750	77.6	402,811	83.2
Alcohol/drugs	292	0.1	4,132	0.9
Speeding	8,970	1.9	11,626	2.4
Alcohol/drugs/speed	0	0.0	301	0.1
Reckless driving	807	0.2	1,832	0.4
Suspended license	696	0.1	1,157	0.2
Failed to yield	9,330	1.9	9,901	2.0
Running traffic signal	3,651	0.8	3,543	0.7
Hit and run	24,999	5.2	5,552	1.1
Unknown violation charged	14,236	2.9	12,196	2.5
Other violation	45,706	9.4	31,387	6.5
Total	484,438	100.0	484,438	100.0

3.2 Traffic violations and driver injury

Using GES data for 1994-1995, truck drivers are cited somewhat more often overall than other drivers in two-vehicle crashes. Table 18 shows that only the truck driver was charged with a traffic violation in 20.8% of two-vehicle, truck-passenger vehicle crashes, while only the passenger vehicle driver was charged with a traffic violation in 14.9% of such crashes. Both drivers were charged in 2.0% of crashes. The difference in the rate of violations charged between the truck driver and passenger vehicle driver is statistically significant.[2]

[2] Standard errors are estimated using the formulas for estimating standard errors in GES in the Technical Appendix of *Traffic Safety Facts 1995*. The present file uses both 1994 and 1995 data, for which the standard errors are slightly different. The differences are small and may be neglected. Formulas for estimating standard errors for 1995 are used.

Table 18
Traffic violations assigned by driver injury
Two-vehicle, truck-passenger vehicle crashes
1994-1995 GES

Violation assigned	Truck and passenger vehicle driver injured: Neither injured	Truck only	Pass. veh. only	Both injured	Unknown	Total
No violations	237,151	2,459	40,839	4,444	3,087	287,980
Truck only	75,280	1,197	17,523	1,975	354	96,328
Pass. veh. Only	43,719	1,523	18,646	2,908	2,155	68,952
Both	6,032	112	2,886	243	0	9,272
Total	362,182	5,290	79,894	9,570	5,596	462,532
	percent assigned violations					
No violations	65.5	46.5	51.1	46.4	55.2	62.3
Truck only	20.8	22.6	21.9	20.6	6.3	20.8
Pass. veh. Only	12.1	28.8	23.3	30.4	38.5	14.9
Both	1.7	2.1	3.6	2.5	0.0	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Interestingly, crashes in which neither driver was injured account for almost all of the difference between the violation rates. The table shows the injury status of both drivers, classified as "neither driver injured," "truck driver only injured," "passenger vehicle driver only injured," "both injured," and "unknown injury." Each driver was charged with violations at about the same rate in crashes where either one or the other driver was injured. Where only the truck driver was injured, about 25% ("truck only" plus "both") of truck drivers and 30.9% passenger vehicle drivers were charged. In truck-passenger vehicle collisions in which only the passenger vehicle driver was injured, the truck driver was charged with a traffic violation in 25.5% of the crashes while the passenger vehicle driver was charged in 27.0% of the crashes. But where neither driver was injured, over 22% of truck drivers were charged with a traffic violation while only 13.7% of passenger vehicle drivers were charged. This difference is also statistically significant.

Thus, while truck drivers are charged with a traffic violation at a somewhat higher rate than the passenger vehicle drivers, the difference is accounted for almost entirely by crashes in which neither driver was injured. In traffic crashes in which either driver was injured, the passenger vehicle driver was charged with a traffic offense at a slightly higher rate than the truck driver, but which driver was injured does not appear to have any overall affect on rates of charging.

If injury crashes are considered alone, truck and passenger vehicle drivers are charged at about the same rate (table 19). The truck driver alone was charged with a traffic violation in 22.8% of the crashes, while the passenger vehicle driver alone was charged in 24.6% of the crashes. This difference is not statistically significant, but even if it were, it would have no practical significance. As in the case of all crashes, the only meaningful difference in the rates at which truck drivers and passenger vehicle drivers were charged with traffic violations is in the case where neither driver was injured.[3] In other words, there is no statistically significant difference between the rates at which either truck drivers or passenger vehicle drivers are charged with traffic violations in injury crashes.

[3] Some other involved party in the crash was injured: a passenger of either vehicle or a nonmotorist.

Table 19
Traffic violations assigned by driver injury
Two-vehicle, truck-passenger vehicle crashes
Injury crashes only
1994-1995 GES

Violation assigned	driver injury: Neither injured	Truck only	Pass. veh. only	Both injured	Unknown	Total
No violations	4,804	2,446	39,000	3,181	586	50,017
Truck only	3,150	1,197	17,199	1,806	0	23,352
Pass. veh. only	2,241	1,448	18,307	2,741	441	25,178
Both	615	112	2,886	243	0	3,855
Total	10,810	5,203	77,392	7,971	1,027	102,401
	percent assigned violations					
No violations	44.4	47.0	50.4	39.9	57.1	48.8
Truck only	29.1	23.0	22.2	22.7	0.0	22.8
Pass. veh. only	20.7	27.8	23.7	34.4	42.9	24.6
Both	5.7	2.1	3.7	3.0	0.0	3.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

When only truck-passenger vehicle crashes that involve property damage are considered, truck drivers are charged with a traffic violation at a higher rate than passenger vehicle drivers (table 20). Almost 22% of truck drivers were charged with a traffic violation, compared with 13.6% of the passenger vehicle drivers. This difference is statistically significant. Obviously, in these crashes, neither driver was injured, so driver injury could not have influenced the relative rate at which violations were charged.

Table 20
Traffic violations assigned
Two-vehicle, truck-passenger vehicle crashes
Property-damage-only crashes
1994-1995 GES

Violation assigned	N	%
No violations	234,824	66.0
Truck only	72,484	20.4
Passenger vehicle only	43,146	12.1
Both	5,417	1.5
Total	355,871	100.0

How should these findings be interpreted? Two questions present themselves: Is there a biasing effect from driver injury? And, in truck-passenger vehicle collisions, which driver bears more culpability?

As to the first question, the data presented show the following relationships between driver injury and the rate at which traffic violations are charged:

- Where neither driver is injured, the truck driver is charged with a traffic violation at a higher rate than the passenger vehicle driver.

- Where the truck driver alone is injured, the passenger vehicle driver is charged at a higher rate.

- Where the passenger vehicle driver alone is injured, each driver is charged at about the same rate.
- Where both are injured, the passenger vehicle driver is charged at a higher rate.

There are two possible biasing effects to driver injury. The first is that the injured driver is unable to defend himself properly to the reporting officer, and therefore is more likely to be charged. The second effect is that the injured party evokes the sympathy of the reporting officer, and therefore is less likely to be charged. These two effects push in opposite directions. Yet, if we take the rate of violations charged where neither driver is injured as reflecting the "true" underlying relative distribution of responsibility for the collision, it is hard to see how the proposed biasing effects of injury are reflected in the rates.

Under the hypothesized biasing effect, truck drivers who are injured are not charged at the same rate as they "should" be, bringing their rate down to that of involved passenger vehicle drivers. But surely the sympathy effect ought to work equally for passenger vehicle drivers. Where the passenger vehicle driver was the only injured driver and thus engaged the reporting officer's sympathy, if truck drivers in general have a higher violation rate, then the spread in the rate of violations charged between the uninjured truck driver and injured passenger vehicle driver should be even greater than when neither is injured. Yet the rates of violations charged are nearly identical when the passenger vehicle driver alone is injured. Similarly, where both are injured, rates of charging should be in the same relation as where neither is injured. However, where both drivers are injured, passenger vehicle drivers are charged at a higher rate.

Yet this evidence should not be overinterpreted. In over 60% of all two-vehicle, truck-passenger vehicle crashes, neither party is assigned a violation. Even in the more serious crash category considered here, crashes in which some involved party is injured, no traffic violation is charged in almost 50% of the cases. For the reasons discussed above, the decision to issue a traffic citation is based on a variety of considerations, including the seriousness of the offense, the existence of sufficient evidence to prove the offense in court, the intent of the violator, and whether other enforcement action might be more effective. All limit the utility of using traffic violations to apportion responsibility for a traffic collision.

4.0 Summary and conclusions

This study examined the relative contribution of truck and passenger vehicle drivers to truck-passenger vehicle traffic crashes. The data used covered fatal crashes, using UMTRI's Trucks Involved in Fatal Accidents file, and nonfatal crashes, using NHTSA's General Estimates System file. Two-vehicle files were constructed for crashes involving one truck and one passenger vehicle, either a car, sport utility vehicle, passenger van, or pickup truck. For fatal crashes, the contribution of each driver was gauged primarily by examining the coding of driver-related factors. These are factors that FARS analysts in each state code to record driver actions that contributed to the crash. The driver-related factors were compared with a separate variable that records the relative movement and position of the vehicles prior to the crash. Certain crash configurations strongly suggest relative contribution to the occurrence of the crash. Accordingly, by examining the coding of driver-related factors by crash configuration, it is possible to evaluate the reliability of the driver-related factors variable.

Driver-related factors are not available in the GES file, so traffic violations were used in the analysis instead. Traffic violations are not as useful in assessing the contribution of driver actions to crashes because police officers issue traffic citations based on a wide variety of considerations, including the seriousness of the offense, the existence of sufficient evidence to prove the charge, the intent of the violator,

and whether other enforcement actions might be more appropriate. Moreover, no traffic citations were issued in 62.3% of the truck-passenger vehicle crashes. Nevertheless, traffic violations are the only data available for nonfatal crashes to assess driver contribution.

Data on driver history was used to characterize the population of truck and passenger vehicle drivers involved in two-vehicle, truck-passenger vehicle fatal crashes. Overall, the previous driving records of truck and passenger vehicle drivers were similar. Higher proportions of truck drivers had been involved in an earlier crash than passenger vehicle drivers (20.3% to 16.1%), had a speeding conviction (28.2% to 19.2%), or had some other previous moving violation (19.2% to 12.8%). On the other hand, passenger vehicle drivers were more likely to have had their driver's license suspended (11.0% to 7.0%) or had a previous driving-while-intoxicated (DWI) conviction (4.2% to 1.1%). In the traffic crashes subject to the analysis, passenger vehicle drivers were much more likely to have been using alcohol or drugs. About 16.2% of passenger vehicle drivers were reported to have been drinking, compared with 1.4% of truck drivers. About 1.3% of passenger vehicle drivers had been using illegal drugs, compared with 0.3% of involved truck drivers.

The passenger vehicle driver was coded with a driver-related factor in almost 81% of fatal two-vehicle, truck-passenger vehicle crashes, and was the only one coded with a driver-related factor in 70.3% of such crashes. Truck drivers survived almost 98% of such fatal crashes, while the passenger vehicle driver was killed in about 83%. (Some other party, most often an occupant of the passenger vehicle, was killed in the remainder.) Accordingly, one hypothesis for the overrepresentation of passenger vehicle drivers is that the surviving truck driver in essence was able to blame the deceased passenger vehicle driver for the crash.

The "surviving driver" explanation appears to be too simple. In fatal truck-passenger vehicle collisions where neither driver was killed, an action by the passenger vehicle driver was found to contribute to the crash in 74.1% of the crashes while the truck driver was found to have contributed to the crash in only 34.1% of the crashes. In other words, in fatal crashes where both drivers survived and presumably were able to tell their side of the story, the distribution of driver-related factors remained close to the overall distribution. One explanation might be that the surviving passenger vehicle driver was so badly injured that he was unable to defend himself. That explanation was not explored.

Examining driver-related factors in light of the crash configuration, however, tends to corroborate the coding of driver-related factors and, by extension, that passenger vehicle drivers contribute disproportionately to fatal truck-passenger vehicle crashes. Truck-passenger vehicle crashes leave physical evidence. Head-on collisions leave gouges in the road showing the point of impact. The juxtaposition of the vehicles after the collision, in combination with the location of damage, can explain how the collision occurred. In some types of fatal crashes, the location of impact or the relative position of the vehicles strongly suggests that one party contributed more heavily than the other. In a rear-end collision, the striking vehicle, to the extent that *driver* error is to blame, most likely contributed more heavily than the struck vehicle. In head-on collisions, the driving error, again to the extent to which *driving* errors contributed, was committed by the driver of the vehicle that crossed the center line into the other lane, rather than the vehicle that remained in its own lane.

Head-ons, rear-ends, and sideswipes are all crash configurations where the configuration and location of the collision itself is a powerful clue to the relative contribution of the drivers involved. Together these crash types account for 53.7% of passenger vehicle driver fatalities in truck-passenger vehicle collisions. In head-on crashes, the impact took place in the truck's lane over eight times as often as in the passenger

vehicle's lane. In opposite direction sideswipes, which are similar to head-on crashes, the passenger vehicle encroached into the truck's lane six times as often as the reverse. And in rearend fatal crashes, the passenger vehicle was the striking vehicle over five times as often as the truck.

The coding of driver-related factors is consistent with what one would expect from the physical configuration of the crash. For example, in head-on collisions where the passenger vehicle crossed the centerline into the truck's lane, the passenger vehicle driver was assigned a driver-related factor in 98.0% of the crashes, compared with 6.9% of the truck drivers. Considering rear-ends, passenger vehicle striking, the passenger vehicle driver was coded with a driver-related factor in 91.3% of the crashes, compared with 19.8% of the truck drivers.

Thus, the majority of truck-passenger vehicle fatal crashes consists of crash types where there is considerable physical evidence about the nature of the crash and the crash configuration itself implies the relative contribution to the crash. And in those crashes, the passenger vehicle driver clearly contributed more heavily to the crash than the truck driver. In rear-ends and head-on crashes, the passenger vehicle driver alone was coded with a factor in 76.0% of the cases, compared with only 12.1% for the truck driver alone. In sideswipes, the passenger vehicle driver alone was coded with a related factor in 77.3% of the cases, compared with 13.3% for the truck driver.

In the remaining fatal truck-passenger vehicle collisions, additional information beyond the physical event is needed to infer relative contribution. Often, what is needed is information about which vehicle had the right-of-way. That information is either lacking or is much less firmly established than the physical evidence of the collision. In these truck-passenger vehicle crashes, the passenger vehicle driver is coded with a driver-related factor at a lower rate, although still more than the truck driver. The passenger vehicle driver alone is coded with a factor in 62.7% of the cases, the truck driver alone in 20.9% of the cases and both were given a factor in 11.5%.

There is some evidence that passenger vehicle drivers commit more of the driving errors in fatal crashes because the errors of the passenger vehicle driver are more likely to lead to a fatality than the other way around. Rear-end collisions provide the clearest example, because a fatality is more likely to occur if a passenger vehicle strikes the rear of a truck, rather than the truck striking the rear of a passenger vehicle. There is less crush space available to the passenger vehicle driver when he strikes the rear of a truck than there is if the truck strikes the passenger vehicle, while the driver's seat may provide some additional protection when a vehicle is rear-ended. Taking the crashes (head-ons, rear-ends and sideswipes) where the crash configuration itself suggests responsibility as a group, passenger vehicle driver errors are much more likely to result in a fatality than truck driver errors. Yet, other than rear-ends, why this is true is not at all clear. And the fact remains that head-on collisions, the most common truck-passenger vehicle fatal crash, overwhelmingly involve the passenger vehicle crossing the centerline into the truck.

The evidence is much less solid in nonfatal crashes for evaluating the relative contribution of passenger vehicle drivers and truck drivers to truck-passenger vehicle collisions. Traffic violations issued is the primary variable to establish fault and no violations were issued in almost two-thirds of the crashes. Moreover, traffic citations are an enforcement tool, rather than an analytical tool. Police officers, properly, exercise judgment as to when it is appropriate to issue a citation.

Overall, truck drivers were charged with a traffic violation more often than passenger vehicle drivers in truck-passenger vehicle collisions. The truck driver only was charged with a traffic violation in 20.8% of

truck-passenger vehicle crashes, compared with 14.9% of passenger vehicle drivers. Both were cited in 2.0% of crashes. Crashes in which neither driver was injured account for almost all the difference between the violation rates. Where the truck driver only was injured, about 25% of truck drivers and 30.9% passenger vehicle drivers were charged. In truck-passenger vehicle collisions in which only the passenger vehicle driver was injured, the truck driver was charged with a traffic violation in 25.5% of the crashes while the passenger vehicle driver was charged in 27.0%. But where neither driver was injured, over 22% of truck drivers were charged with a traffic violation while only 13.7% of passenger vehicle drivers were charged. In property-damage-only crashes, almost 22% of truck drivers were charged with a violation, compared with 13.6% of passenger vehicle drivers.

In sum, it appears that in fatal truck-passenger vehicle collisions, the passenger vehicle does contribute more heavily to the crash than the truck. This finding is most firmly established in crashes where the physical nature of the collision suggests responsibility. For nonfatal truck-passenger vehicle crashes, the evidence is considerably less clear. Only the partial evidence of traffic violations is available in existing crash data sets. Nevertheless, it does appear in nonfatal truck-passenger vehicle crashes that truck drivers may contribute somewhat more than passenger vehicle drivers, though this conclusion is tentative.

This research has identified questions warranting further analysis. Why do most head-on collisions occur in the truck's lane? In such crashes, almost 70% of the passenger vehicle drivers are coded as failing to stay in their own lane, which identifies the problem without explaining it. Related analyses would pursue the question of the relative contribution of passenger vehicle and truck drivers in nonfatal accidents using state data. Certain state files might contain information on driver errors, regardless of whether a traffic violation was issued. Such information would be an improvement over the use of traffic violations.

Finally, while the driver-related factors variable is a rich source of information and one that certainly warrants further work, it is clear that additional data are needed that bear more directly on the question of the relative contribution of drivers, or vehicles or the environment, to the occurrence of traffic crashes. The driver-related factors variables are coded by analysts not on the scene or directly involved in the investigation. In-depth investigation of crashes, specifically designed to identify crash causation, would be very useful in resolving some of the issues raised in this paper.

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Appendix

Driver-Related Factors for Truck and Passenger Vehicle Driver for each Accident Type
Truck-Passenger Vehicle Fatal Crashes
Trucks Involved in Fatal Accidents, 1994-1995

Driver-related factors for accident type: Rearend, truck striking

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	99	56.6
Stopping in road	26	14.9
Drowsy, asleep	8	4.6
Improper lights	7	4.0
Failure to yield	7	4.0
Improper lane change	6	3.4
Erratic/reckless	6	3.4
Too fast for conditions	5	2.9
Under minimum speed	3	1.7
Inattentive	3	1.7
W/O required equipment	3	1.7
Ill, blackout	2	1.1
Drugs-medication	2	1.1
Vehicle unattended	2	1.1
Improper towing	2	1.1
Failure to keep in lane	2	1.1
Improper entry/exit	2	1.1
Improper start/backing	2	1.1
Other vision obstruction	2	1.1
Failure to signal	1	0.6
Improper following	1	0.6
Flat tire	1	0.6
Homicide	1	0.6
Unknown	10	5.7
Total passenger vehicle	175	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	51	29.1
Too fast for conditions	39	22.3
Improper following	32	18.3
Inattentive	28	16.0
Homicide	21	12.0
Erratic/reckless	16	9.1
Failure to keep in lane	14	8.0
Drowsy, asleep	9	5.1
Other nonmoving violation	7	4.0
Improper lane change	5	2.9
Avoiding vehicle in road	5	2.9
W/O required equipment	4	2.3
Vision obscured by moving vehicle	4	2.3
Hit-and-run	4	2.3
Failure to obey signs/signals	3	1.7
Failure to yield	2	1.1
Ill, blackout	2	1.1
Passing w/insufficient distance	2	1.1
Slippery surface	2	1.1
Passing around barrier	1	0.6
Failure to observe vehicle warnings	1	0.6
Stopping in road	1	0.6
Vision obscured by rain, etc	1	0.6
Unknown	4	2.3
Total truck	175	100.0

Driver-related factors for accident type: Rearend, passenger vehicle striking

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	36	5.5
Too fast for conditions	291	44.8
Improper following	144	22.2
Inattentive	136	21.0
Erratic/reckless	99	15.3
Improper lane change	25	3.9
Failure to observe vehicle warnings	22	3.4
Failure to keep in lane	19	2.9
Drowsy, asleep	17	2.6
Other non-moving violation	16	2.5
Homicide	15	2.3
Other drugs	13	2.0
Failure to yield	10	1.5
Passing w/insufficient distance	9	1.4
Ill, blackout	8	1.2
Vision obscured by rain, etc	8	1.2
Failure to obey signs/signals	7	1.1
W/O required equipment	6	0.9
Other improper turn	6	0.9
Glare	6	0.9
Other physical impairment	4	0.6
Slippery surface	4	0.6
Water, snow, or oil on road	4	0.6
Hit-and-run	3	0.5
Drugs-medication	2	0.3
Failure to comply w/physical restrictions	2	0.3
Operator inexperience	2	0.3
Stopping in road	2	0.3
Other vision obstruction	2	0.3
Avoiding vehicle in road	2	0.3
Fax machine	2	0.3
Deaf	1	0.2
Unlawful noise	1	0.2
Unknown	17	2.6
Total passenger vehicle	649	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	515	79.4
Stopping in road	39	6.0
Vehicle unattended	31	4.8
Other nonmoving violation	15	2.3
Under minimum speed	15	2.3
W/O required equipment	9	1.4
Improper loading	7	1.1
Failure to yield	6	0.9
Inattentive	6	0.9
Improper following	4	0.6
Hit-and-run	2	0.3
Improper lane change	2	0.3
Improper entry/exit	2	0.3
Failure to signal	2	0.3
Turning from wrong lane	2	0.3
Homicide	2	0.3
Passing w/insufficient distance	1	0.2
Improper lights	1	0.2
Too fast for conditions	1	0.2
Unknown	6	0.9
Total truck	649	100.0

Driver-related factors for accident type: Sideswipe, same direction, truck encroaching

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	32	65.3
Failure to keep in lane	7	14.3
Too fast for conditions	6	12.2
Water, snow, or oil on road	4	8.2
Improper following	3	6.1
Over correcting	3	6.1
Inattentive	2	4.1
Improper lane change	2	4.1
Passing on wrong side	2	4.1
Passing w/insufficient distance	1	2.0
Unknown	2	4.1
Total passenger vehicle	49	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	8	16.3
Improper lane change	23	46.9
Inattentive	11	22.4
Failure to keep in lane	10	20.4
Failure to yield	5	10.2
Homicide	7	14.3
Too fast for conditions	6	12.2
Hit-and-run	5	10.2
Passing w/insufficient distance	2	4.1
Failure to obey signs/signals	2	4.1
Avoiding pedestrian	2	4.1
Other nonmoving violation	2	4.1
Improper loading	1	2.0
Passing on wrong side	1	2.0
Erratic/reckless	1	2.0
Other vision obstruction	1	2.0
Total truck	49	100.0

Driver-related factors for accident type: Sideswipe, same direction, passenger vehicle encroaching

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	4	3.3
Failure to keep in lane	50	41.7
Improper lane change	31	25.8
Too fast for conditions	30	25.0
Erratic/reckless	18	15.0
Water, snow, or oil on road	13	10.8
Other improper turn	12	10.0
Inattentive	8	6.7
W/O required equipment	7	5.8
Failure to yield	7	5.8
Over correcting	7	5.8
Homicide	7	5.8
Drowsy, asleep	4	3.3
Improper loading	2	1.7
Passing on wrong side	2	1.7
Passing w/insufficient distance	2	1.7
Failure to signal	2	1.7
Erratic speed changes	2	1.7
Unfamiliar w/road	2	1.7
Slippery surface	2	1.7
Debris in road	2	1.7
Other non-moving violation	2	1.7
Flat tire	1	0.8
Total passenger vehicle	120	100.0

Factors coded for truck driver

Driver related factors	N	%
None	108	90.0
Hit-and-run	6	5.0
Too fast for conditions	4	3.3
Water, snow, or oil on road	2	1.7
Other nonmoving violation	2	1.7
Total truck	120	100.0

Driver-related factors for accident type: Head-on, truck encroaching

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	134	85.9
Failure to keep in lane	9	5.8
Water, snow, or oil on road	4	2.6
Too fast for conditions	3	1.9
Drowsy, asleep	2	1.3
Inattentive	2	1.3
Erratic/reckless	2	1.3
Wrong way	2	1.3
Vision obscured by rain, etc	2	1.3
Glare	2	1.3
Avoiding vehicle in road	2	1.3
Hit-and-run	2	1.3
Failure to yield	1	0.6
Locked wheel	1	0.6
Total passenger vehicle	156	100.0

Factor coded for truck driver

Driver-related factor	N	%
None	12	7.7
Failure to keep in lane	95	60.9
Too fast for conditions	58	37.2
Homicide	26	16.7
Wrong side of road	23	14.7
Inattentive	20	12.8
Avoiding vehicle in road	18	11.5
Erratic/reckless	9	5.8
Improper following	8	5.1
Other nonmoving violation	7	4.5
Drowsy, asleep	5	3.2
Passing w/insufficient distance	5	3.2
W/O required equipment	3	1.9
Avoiding phantom vehicle	3	1.9
Water, snow, or oil on road	3	1.9
Improper lane change	2	1.3
Other drugs	2	1.3
Passing prohibited	2	1.3
Failure to yield	2	1.3
Wrong way	2	1.3
Slippery surface	2	1.3
Flat tire	2	1.3
Avoiding rut in road	2	1.3
Avoiding live animal	1	0.6
High speed chase	1	0.6
Failure to signal	1	0.6
Other improper turn	1	0.6
Locked wheel	1	0.6
Over correcting	1	0.6
Total truck	156	100.0

Driver-related factors for accident type: Head-on, passenger vehicle encroaching

Factor coded for passenger vehicle driver

Driver-related factor	N	%
None	20	1.6
Failure to keep in lane	862	69.7
Too fast for conditions	204	16.5
Wrong side of road	199	16.1
Inattentive	92	7.4
Water, snow, or oil on road	83	6.7
Drowsy, asleep	72	5.8
Erratic/reckless	71	5.7
Failure to yield	45	3.6
Passing w/insufficient distance	31	2.5
Over correcting	28	2.3
Other improper turn	26	2.1
Other non-moving violation	17	1.4
Ill, blackout	15	1.2
Other drugs	15	1.2
Slippery surface	15	1.2
Vision obscured by rain, etc	12	1.0
Passing prohibited	11	0.9
Wrong way	10	0.8
Failure to obey signs/signals	9	0.7
Avoiding vehicle in road	8	0.6
Operator inexperience	6	0.5
Homicide	6	0.5
Other physical impairment	5	0.4
Mother of dead fetus	5	0.4
Improper lane change	5	0.4
Improper loading	4	0.3
Improper lights	4	0.3
High speed chase	4	0.3
Under minimum speed	4	0.3
Vision obstructed by curve, hill, etc	4	0.3
Avoiding live animal	4	0.3
Improper entry/exit	3	0.2
Passing on wrong side	3	0.2
W/O required equipment	2	0.2
Erratic speed changes	2	0.2
Vision obscured by moving vehicle	2	0.2
Hit-and-run	2	0.2
Cellular phone	2	0.2
Emotional	1	0.1
Improper following	1	0.1
Unfamiliar w/road	1	0.1
Stopping in road	1	0.1
Low tire pressure	1	0.1
Glare	1	0.1
Debris in road	1	0.1
Unknown	5	0.4
Total passenger vehicle	1236	100.0

Factor coded for truck driver

Driver-related factor	N	%
None	1146	92.7
Other nonmoving violation	22	1.8
Failure to keep in lane	17	1.4
Too fast for conditions	16	1.3
Water, snow, or oil on road	9	0.7
Vision obscured by rain, etc	8	0.6
Homicide	4	0.3
Improper loading	4	0.3
Wrong side of road	4	0.3
Vision obstructed by curve, hill, etc	4	0.3
Avoiding vehicle in road	4	0.3
W/O required equipment	3	0.2
Passing prohibited	2	0.2
Passing w/insufficient distance	2	0.2
Drowsy, asleep	2	0.2
Drugs-medication	2	0.2
Inattentive	2	0.2
Improper lane change	2	0.2
Erratic/reckless	2	0.2
Failure to yield	2	0.2
Slippery surface	2	0.2
Locked wheel	1	0.1
Hit-and-run	1	0.1
Unknown	3	0.2
Total truck	1236	100.0

Driver-related factors for accident type: Sideswipe, opposite direction, truck encroaching

Factor coded for passenger vehicle driver

Driver-related factor	N	%
None	46	68.7
Failure to keep in lane	14	20.9
Erratic/reckless	4	6.0
Too fast for conditions	3	4.5
Drowsy, asleep	2	3.0
Unknown	3	4.5
Total passenger vehicle	67	100.0

Factor coded for truck driver

Driver-related factor	N	%
None	16	23.9
Failure to keep in lane	33	49.3
Too fast for conditions	14	20.9
Homicide	12	17.9
Wrong side of road	8	11.9
Inattentive	6	9.0
Water, snow, or oil on road	6	9.0
Other nonmoving violation	4	6.0
Improper loading	3	4.5
Avoiding vehicle in road	3	4.5
Erratic/reckless	2	3.0
Failure to yield	2	3.0
Passing prohibited	1	1.5
Avoiding live animal	1	1.5
Unknown	3	4.5
Total truck	67	100.0

Driver-related factors for accident type: Sideswipe, opposite direction, passenger vehicle encroaching

Factor coded for passenger vehicle driver

Driver-related factor	N	%
None	7	1.8
Failure to keep in lane	299	77.5
Too fast for conditions	82	21.2
Wrong side of road	41	10.6
Water, snow, or oil on road	30	7.8
Drowsy, asleep	29	7.5
Inattentive	28	7.3
Erratic/reckless	22	5.7
Other non-moving violation	17	4.4
Failure to yield	12	3.1
Over correcting	10	2.6
Other improper turn	9	2.3
Improper lane change	6	1.6
Avoiding vehicle in road	4	1.0
Failure to obey signs/signals	3	0.8
Wrong way	3	0.8
Cellular phone	3	0.8
Ill, blackout	2	0.5
Mother of dead fetus	2	0.5
Improper entry/exit	2	0.5
Operator inexperience	2	0.5
Unfamiliar w/road	2	0.5
Vision obscured by rain, etc	2	0.5
Homicide	2	0.5
Slippery surface	1	0.3
Avoiding phantom vehicle	1	0.3
Unknown	2	0.5
Total passenger vehicle	386	100.0

Factor coded for truck driver

Driver-related factor	N	%
None	357	92.5
Other nonmoving violation	7	1.8
Water, snow, or oil on road	4	1.0
Wrong side of road	3	0.8
Ill, blackout	2	0.5
Improper loading	2	0.5
Failure to comply w/physical restrictions	2	0.5
Vision obscured by rain, etc	2	0.5
Flat tire	2	0.5
Avoiding phantom vehicle	2	0.5
Hit-and-run	2	0.5
Failure to keep in lane	1	0.3
Too fast for conditions	1	0.3
Unknown	2	0.5
Total truck	386	100.0

Driver-related factors for accident type: Truck turn across path

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	105	47.1
Too fast for conditions	64	28.7
Failure to obey signs/signals	28	12.6
Failure to yield	23	10.3
Erratic/reckless	12	5.4
Vision obscured by rain, etc	8	3.6
Passing w/insufficient distance	5	2.2
Failure to keep in lane	4	1.8
Inattentive	4	1.8
Passing prohibited	3	1.3
Other drugs	2	0.9
Other physical impairment	2	0.9
Improper lights	2	0.9
Improper lane change	2	0.9
Wrong side of road	2	0.9
Operator inexperience	2	0.9
Water, snow, or oil on road	2	0.9
Homicide	2	0.9
Unknown	6	2.7
Total passenger vehicle	223	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	90	40.36
Failure to yield	84	37.67
Other improper turn	33	14.80
Homicide	31	13.90
Inattentive	10	4.48
Other nonmoving violation	8	3.59
Erratic/reckless	7	3.14
Vision obscured by rain, etc	6	2.69
Failure to obey signs/signals	5	2.24
W/O required equipment	4	1.79
Improper entry/exit	4	1.79
Wrong side of road	4	1.79
Hit-and-run	4	1.79
Failure to keep in lane	3	1.35
Improper start/backing	2	0.90
Passing around barrier	2	0.90
Stopping in road	2	0.90
Improper lane change	1	0.45
Unknown	5	2.24
Total truck	223	100.00

Driver-related factors for accident type: Passenger vehicle turn across path

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	35	7.1
Failure to yield	308	62.1
Other improper turn	68	13.7
Failure to obey signs/signals	64	12.9
Inattentive	51	10.3
Failure to keep in lane	44	8.9
Erratic/reckless	35	7.1
Too fast for conditions	19	3.8
Improper lane change	9	1.8
Glare	9	1.8
Water, snow, or oil on road	8	1.6
Other non-moving violation	8	1.6
Improper entry/exit	6	1.2
Failure to signal	6	1.2
Wrong Lane Turn	6	1.2
Homicide	4	0.8
Other physical impairment	4	0.8
Vision obscured by moving vehicle	4	0.8
Avoiding vehicle in road	4	0.8
Improper lights	3	0.6
Operator inexperience	3	0.6
Drowsy, asleep	2	0.4
Emotional	2	0.4
Passing on wrong side	2	0.4
Erratic speed changes	2	0.4
Wrong way	2	0.4
Wrong side of road	2	0.4
Over correcting	2	0.4
Vision obscured by rain, etc	2	0.4
Vision obscured by angles on vehicle	2	0.4
Passing w/insufficient distance	1	0.2
Unfamiliar w/road	1	0.2
Total passenger vehicle	496	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	395	79.6
Too fast for conditions	23	4.6
Failure to obey signs/signals	18	3.6
Failure to yield	16	3.2
Other nonmoving violation	15	3.0
Passing w/insufficient distance	12	2.4
Inattentive	9	1.8
Homicide	7	1.4
Erratic/reckless	6	1.2
W/O required equipment	5	1.0
Glare	4	0.8
Vision obscured by moving vehicle	4	0.8
Passing prohibited	3	0.6
Improper loading	2	0.4
Improper following	2	0.4
Improper lane change	2	0.4
Failure to keep in lane	2	0.4
Locked wheel	2	0.4
Vision obscured by rain, etc	2	0.4
Drowsy, asleep	1	0.2
Vision obstructed by curve, hill, etc	1	0.2
Unknown	4	0.8
Total truck	496	100.0

Driver-related factors for accident type: Intersecting straight paths, truck into passenger vehicle

Factors coded for passenger vehicle driver

Driver-related factor	N	
None	133	14.4
Failure to yield	556	60.1
Failure to obey signs/signals	329	35.6
Inattentive	97	10.5
Too fast for conditions	22	2.4
Other non-moving violation	17	1.8
Erratic/reckless	16	1.7
Vision obscured by rain, etc	11	1.2
Vision obstructed by curve, hill, etc	9	1.0
Homicide	9	1.0
Improper entry/exit	6	0.6
Glare	6	0.6
Other vision obstruction	6	0.6
Unfamiliar w/road	5	0.5
Vision obscured by trees, plants	5	0.5
Vision obscured by moving vehicle	5	0.5
Other drugs	4	0.4
Improper loading	4	0.4
W/O required equipment	4	0.4
Other improper turn	4	0.4
Vision obscured by building, billboard	4	0.4
Water, snow, or oil on road	4	0.4
Failure to keep in lane	3	0.3
Stopping in road	3	0.3
Vision obscured by parked vehicle	2	0.2
Drowsy, asleep	2	0.2
Driving on shldr, median, etc	2	0.2
Failure to observe vehicle warnings	2	0.2
Crosswind	2	0.2
Hit-and-run	2	0.2
High speed chase	1	0.1
Unknown	9	1.0
Total passenger vehicle	925	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	716	77.4
Failure to obey signs/signals	98	10.6
Failure to yield	60	6.5
Homicide	29	3.1
Too fast for conditions	28	3.0
Other nonmoving violation	24	2.6
Vision obscured by rain, etc	14	1.5
Inattentive	13	1.4
W/O required equipment	12	1.3
Erratic/reckless	7	0.8
Vision obstructed by curve, hill, etc	5	0.5
Vision obstructed by parked vehicle	4	0.4
Drowsy, asleep	4	0.4
Vision obstructed by trees, plants	4	0.4
Vision obscured by moving vehicle	4	0.4
Avoiding vehicle in road	4	0.4
Water, snow, or oil on road	4	0.4
Locked wheel	3	0.3
Vision obstructed by building, billboard	2	0.2
Other physical impairment	1	0.1
Passing on wrong side	1	0.1
Failure to comply w/physical restrictions	1	0.1
Glare	1	0.1
Unknown	5	0.5
Total truck	925	100.0

Driver-related factors for accident type: Intersecting straight paths, passenger vehicle into truck

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	67	22.6
Failure to obey signs/signals	145	49.0
Failure to yield	111	37.5
Too fast for conditions	52	17.6
Inattentive	29	9.8
Erratic/reckless	12	4.1
Homicide	10	3.4
Vision obscured by rain, etc	6	2.0
Other non-moving violation	5	1.7
Other drugs	3	1.0
Vision obstructed by curve, hill, etc	3	1.0
Improper lane change	2	0.7
Failure to keep in lane	2	0.7
Locked wheel	2	0.7
Vision obscured by building, billboard	2	0.7
Slippery surface	2	0.7
W/O required equipment	1	0.3
Drugs-medication	1	0.3
Impaired by previous injury	1	0.3
Other vision obstruction	1	0.3
Unknown	1	0.3
Total passenger vehicle	296	100.0

Factors coded for truck driver

Driver-related factor	N	%
None	190	64.2
Failure to yield	57	19.3
Failure to obey signs/signals	26	8.8
Other nonmoving violation	12	4.1
Too fast for conditions	10	3.4
Homicide	8	2.7
Inattentive	6	2.0
Erratic/reckless	6	2.0
Vision obscured by rain, etc	6	2.0
Unfamiliar with road	4	1.4
Vision obstructed by curve, hill, etc	3	1.0
Drowsy, asleep	2	0.7
Stopping in road	2	0.7
Vision obstructed by building, billboard	2	0.7
Slippery surface	2	0.7
W/O required equipment	1	0.3
Unknown	5	1.7
Total truck	296	100.0

Driver-related factors for accident type: Other accident type

Factors coded for passenger vehicle driver

Driver-related factor	N	%
None	229	45.3
Failure to keep in lane	74	14.6
Too fast for conditions	62	12.3
Inattentive	36	7.1
Failure to yield	29	5.7
Water, snow, or oil on road	28	5.5
Failure to obey signs/signals	25	4.9
Erratic/reckless	17	3.4
Drowsy, asleep	14	2.8
Stopping in road	14	2.8
Other non-moving violation	13	2.6
Other improper turn	9	1.8
Wrong side of road	6	1.2
Avoiding vehicle in road	6	1.2
Improper lane change	5	1.0
Ill, blackout	5	1.0
Improper start/backing	5	1.0
Over correcting	5	1.0
Glare	5	1.0
Hit-and-run	4	0.8
Improper entry/exit	4	0.8
Unfamiliar w/road	4	0.8
Debris in road	3	0.6
Vehicle unattended	3	0.6
Vision obscured by rain, etc	3	0.6
Vision obscured by moving vehicle	3	0.6
Passing prohibited	2	0.4
Passing w/insufficient distance	2	0.4
Improper following	2	0.4
Impaired by previous injury	2	0.4
High speed chase	2	0.4
Failure to observe vehicle warnings	2	0.4
Wrong way	2	0.4
Underride parked truck	2	0.4
Locked wheel	2	0.4
Flat tire	2	0.4
Slippery surface	1	0.2
Vision obstructed by curve, hill, etc	1	0.2
Drugs-medication	1	0.2
Avoiding phantom vehicle	1	0.2
Homicide	1	0.2
Unknown	17	3.4
Total passenger vehicle	506	100.0

Driver-related factors for accident type: Other accident type

Factors coded for truck driver

Driver-related factor	N	%
None	231	45.7
Failure to keep in lane	58	11.5
Too fast for conditions	54	10.7
Homicide	30	5.9
Erratic/reckless	24	4.7
Failure to yield	23	4.5
Inattentive	22	4.3
Improper start/backing	21	4.2
Stopping in road	18	3.6
Improper loading	18	3.6
Other nonmoving violation	17	3.4
Other improper turn	15	3.0
Failure to obey signs/signals	14	2.8
W/O required equipment	12	2.4
Water, snow, or oil on road	12	2.4
Vehicle unattended	11	2.2
Flat tire	8	1.6
Improper following	7	1.4
Hit-and-run	6	1.2
Slippery surface	6	1.2
Wrong side of road	6	1.2
Vision obscured by rain, etc	5	1.0
Avoiding vehicle in road	5	1.0
Drowsy, asleep	4	0.8
Improper entry/exit	4	0.8
Over correcting	4	0.8
Improper towing	4	0.8
Vision obstructed by curve, hill, etc	3	0.6
Travelling on prohibited trafficway	2	0.4
Passing prohibited	2	0.4
Wrong way	2	0.4
Operator inexperience	2	0.4
Vision obstructed by trees, plants	2	0.4
Avoiding phantom vehicle	2	0.4
Improper lane change	1	0.2
Unknown	10	2.0
Total truck	506	100.0