Highway Accident Comparison after Implementation of the San Pedro Bay Ports Clean Truck Program

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Abstract

In an attempt to improve air quality, the Port of Long Beach (POLB) and Port of Los Angeles (POLA) implemented their joint Clean Truck Program (CTP) with stringent limits on the trucks allowed to dray containers from their terminals. As a result, many trucks serving the POLB were either banned or required expensive retrofitting to reduce diesel emissions. The POLA implemented similar restrictions along with an additional ban on trucks that are independently owned and operated. Accordingly, the CTP reduced the number of independent owner operators providing drayage services at these ports. Independent owner operators fall under criticism for being more dangerous than other commercial truck drivers. Some argue that fierce competition and thin profit margins lead them to drive more aggressively and cut corners when it comes to safely maintaining their trucks. This study investigates whether the CTP impacted safety on highways surrounding the POLB and POLA. Weekly accident and traffic data from highways carrying heavy drayage traffic, namely Interstates 110 and 710, are analyzed to determine if the risk of an accident fell on these highways after the CTP's implementation. Results, using a negative binomial regression framework, suggest no significant change in accident risk after the CTP implementation.

Introduction

It is no surprise that America's transportation industry has become heavily dependent on trucks. In fact, the labor-intensive trucking industry is vital to the mass production and distribution of our goods. This study focuses on a particular subset of trucking known as drayage, which plays a key role in this movement of goods. Drayage refers to the short-haul truck transportation of ocean containers to and from seaports. Specifically, the two ports that this study concentrates on are the Port of Los Angeles and the Port of Long Beach, which together are known as the San Pedro Bay (SPB) Ports.

In October 2008, the Port of Los Angeles and the Port of Long Beach each implemented its own Clean Truck Program. In order to reduce diesel emissions, the program permanently bans older trucks from serving its ports. The removal of these trucks from serving the SPB ports is expected to decrease competition in the drayage market and improve safety on the neighboring highways. Thus, weekly accident and traffic data from highways surrounding these ports are analyzed to determine if accident risks decreased after the implementation of the Clean Truck Program. A brief history of how the trucking industry has changed over the last few decades into the fiercely competitive drayage market that stands now, followed by the San Pedro Bay Ports Clean Truck Programs' impact on drayage traffic will be discussed further.

Deregulation. The beginning of a successful attempt to deregulate America's transportation industry in the 1970s eventually led to drastic changes in the trucking industry. The regulated industry's former characteristics began to reverse and ultimately resulted in the current more independent market. Pricing decisions were previously made by rate bureaus and prevented competition from controlling profits. Additionally, blocked entry into the industry prevented the drayage market from becoming overly competitive. The transfer from government regulation to economic deregulation ultimately removed the former barriers of entry and allowed free entry into the market. As large firms exited the trucking industry, a noticeable amount of smaller non-union firms entered and increased competition (Monaco, 2010, p. 26). In fact, the trucking industry can now be labeled a fragmented industry because the 50 largest national companies only hold 40% of the market revenue (First Research, 2010).

The lack of regulatory and financial barriers to enter the market attracted new firms who were able to start their own drayage business with fewer hindrances. The large number of new firms who entered the market resulted in a tremendous amount of competition that firms currently face. This intense competition causes firms to become price-takers, as they have little or no negotiating power over pricing decisions. As a result, the majority of the drayage market consists of price-takers competing among a plethora of dray drivers to earn minimal profits.

In *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation*, Michael Belzer, a prominent expert in the trucking industry, summarizes how government deregulation has affected America's interstate trucking industry. Belzer compares the trucking industry to America's sweatshops where workers earn low pay while working long hours in unsafe and unsanitary conditions. His book shows how economic deregulation of the trucking industry has brought intense competition, low wages, long hours, and a constant struggle to maintain safe operations in a hyper-competitive environment (2000, p. 157). Such conditions are also extremely common in the drayage industry. Indeed, dray drivers serving the SPB Ports report working an average of at least 11 hours a day and 60 hours a week (Monaco, 2008). Long hours and low wages, along with the intense amount of competition for work are all thought to contribute to unsafe practices in the drayage market.

Dray Driver Safety Concerns. Easy entrance into the port drayage market has resulted in the majority of the labor sector consisting of drivers who own the truck that they operate. These dray drivers are known as independent owner operators. Recent studies have found that owner operators make up around 80% of the total dray drivers that serve the SPB ports (Monaco, 2010; Monaco, 2008; Monaco & Grobar, 2004). Due to ferocious price competition in the drayage market, independent owner operators have become price-takers who usually earn minimal profits and are left with low net incomes and little net worth (Husing, Brightbill, & Crosby, 2007, p. i). Monthly expenditures, such as truck maintenance, gas, and insurance, become difficult to afford as these dray drivers barely earn enough to stay in business. Reportedly, operating ratios of the motor carriage industry show that costs absorb well over 90% of revenues (Husing et al., 2007, p. 22). For this reason, independent owner operators often postpone necessary truck maintenance and repairs. Thus, criticism has arisen concerning these dray drivers and the safety of some of their practices.

In a 2008 *Los Angeles Times* article "Unsafe Trucks Stream Out of L.A.'s Ports," staff writer Louis Sahagun interviews an independent operator who serves the Port of Los Angeles and uncovers a number of unsafe practices common to the drayage industry. He cites the independent owner operator's 24-year-old poorly maintained and overloaded truck, its shot suspension, bald tires, and untrustworthy brakes as one example. Sahagun notes that since profit margins are thin for these drivers, emergency repairs sometimes have to wait and some independent owner operators cut corners whenever possible. Hence, drivers resort to makeshift repairs such as lashing bumpers to chassis with bungee cords, smearing mud over cracked parts, and even regrooving tread into bald tires. These makeshift repairs, along with illegal practices such as hauling heavy loads that exceed regulation limits or using trailer brakes to stop the entire truck, cause drivers to fear enforcement officers. Drivers are known to warn each other over the CB radio about California Highway Patrol (CHP) checkpoint locations. In doing so, drivers attempt to elude CHP checkpoints by driving their big rigs through local neighborhoods (Sahagun, 2008).

In an attempt to eliminate independent owner operators Assembly Bill 950 (2011) was proposed: "This bill would deem drayage truck operators as employees of those persons who arrange for or engage their services" (AB 950, 2011, p. 1). The political bill claims that drayage truck driving is more dangerous than other forms of commercial driving, specifically noting safety, worker health and public health as areas of concern. Problems such as drayage trucks carrying heavy weights and large loads, frequent trips made through neighborhoods, and truck pollution are all listed to support the claim that drayage truck driving is more dangerous than other forms of truck transportation.

According to a statewide database, Interstate 710, known as the Long Beach Freeway, in recent years averaged an annual 2,000 accidents and about one-third of them involved trucks. Hundreds of these accidents were caused by road debris that is often shed by trucks (Sahagun, 2008). The general concern is that dray drivers use dangerous methods to cut costs at the expense of public safety. Thus, this study investigates the latter safety concern by focusing on accident data from highways carrying large concentrations of drayage trucks. Special attention is paid to the routes that directly serve the ports in order to investigate whether the routes with the highest concentration of drayage traffic are more dangerous.

The Clean Truck Program. The Port of Los Angeles (POLA) and the Port of Long Beach (POLB) teamed up to reduce air pollution and health risks through the San Pedro Bay Ports Clean Air Action Plan. A major component of the plan that concentrates on reducing truck air pollution is the Clean Truck Program (CTP). The program aims to improve air quality by establishing a set of progressive bans on older trucks known to emit diesel air pollution. By 2012, the CTP aims to reduce truck-related air pollution by 80% to meet the 2007 Environmental Protection Agency (EPA) heavy-duty truck emission standards.

Both of the Ports of Los Angeles and Long Beach implemented their own Clean Truck Program. Both CTPs commenced in October 2008 with the first ban on pre-1989 trucks. The POLA reported at least 1,500 pre-1989 trucks were removed from serving its port after the first ban took effect. The second set of enforcements occurred in January 2010 where pre-1993 trucks were banned and restrictions were placed on 1994-2003 trucks. In August 2010, the POLA estimated that over 90% of the trucks serving its port were clean trucks that met the 2007 EPA emission standards (The Port of Los Angeles, 2011a).

Truck owners who desire to continue serving these ports have the option of either retrofitting their old truck engine to meet the 2007 EPA emission standards or seek the alternative of using a newer truck through lease or purchase. As of January 2012, only trucks meeting the 2007 EPA standards will be allowed to serve the SPB ports. Both options of retrofitting an old truck engine or pursuing a newer truck are quite costly, especially for the independent owner operators who could barely afford to stay in business before the program began. For independent owner operators who own older trucks, the high cost of complying with the CTP bans may lead them to exit the drayage market. In a survey conducted of dray drivers at the SPB ports, over 95% of the trucks being used were models 2003 and older (Monaco, 2010, p. 31). The exit of these drivers from the drayage market would decrease competition and theoretically increase profitability for the remaining dray drivers.

Although the CTP is environmentally based, it may also have an impact on safety in the drayage market. Both CTPs contain aspects that are thought to improve safety such as the CTP Concession Program that holds concessionaires responsible for operating trucks that meet vehicle safety and maintenance standards and the safety training of drivers. Although the POLA tried to permanently implement a further restriction on independent owner operators in an attempt to only serve employee drivers, the U.S. 9th Circuit Court of Appeals ruled against them and the employee driver restriction is no longer enforced at the POLA (The Port of Los Angeles, 2011b). Although the fundamental intent of the Clean Truck Program is to reduce air emissions at the San Pedro Bay Ports, one of its unintended effects may be to significantly reduce competition in the port drayage sector (Husing et al., 2007, p. 79).

Essentially, a decrease in the amount of competition in the drayage market is expected due to the safety benefits from the CTP Concession Program and the removal of owner operators who are no longer able to afford to serve the SPB Ports because of the Clean Truck Program restrictions. Although the POLA estimated the removal of many older trucks from serving its port after the CTP enforcements, and presumably the POLB Clean Truck Program successfully removed older trucks from serving its port as well, the extent to which the removal of these trucks decreased competition is uncertain. Nonetheless, the effect that the removal of these trucks may have on highway safety is investigated.

Methodology

Empirical Setting. The San Pedro Bay port complex consists of the two busiest ports in the northern hemisphere, the Port of Los Angeles and the Port of Long Beach. Respectively, the Southern California ports rank first and second with respect to container traffic in the United States. And when combined, the San Pedro Bay Port complex ranks fifth busiest in the world (Monaco, 2010, p. 23). Accordingly, the nearest highways to these ports, Interstates 110 and 710, contain high levels of drayage traffic. As seen in Figure 1, Interstate 710 directly serves the Port of Long Beach and Interstate 110 serves the Port of Los Angeles (Google Maps, 2011). Interstates 110 and 710 are thought to contain the heaviest concentrations of drayage traffic when compared to other California highways because of their close proximity to the San Pedro Bay Port complex. Therefore, special attention is paid to these two highways when analyzing the accident risks of all the highways measured in this study.

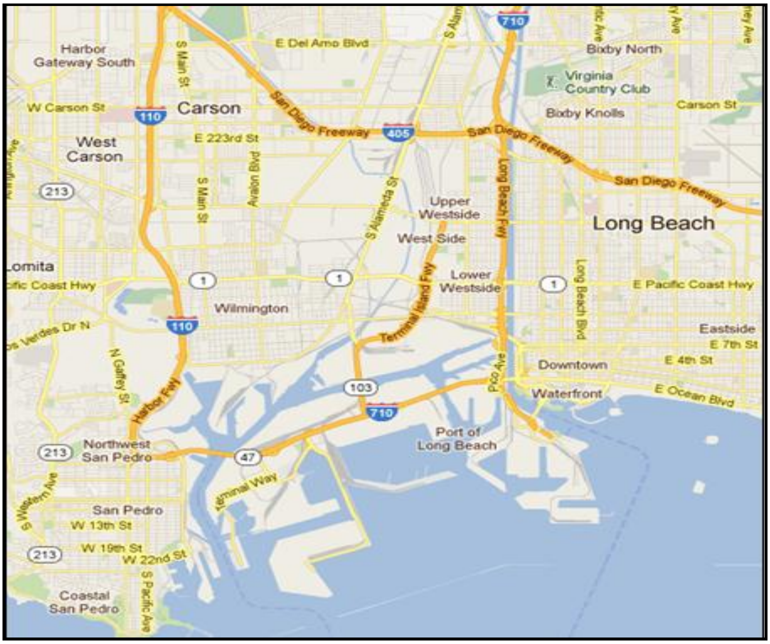

Figure 1. The San Pedro Bay Port complex and Interstates 110 and 710. Adapted from Google Maps. Copyright 2011 by Google.

Figure 2 highlights the five California highways analyzed in this research (Google Maps, 2011). The northbound and southbound segments of Interstates 710 and 110 through Interstate 10, the eastbound and westbound segment of Interstate 10 bounded by Interstate 110 and State Route 57, and the eastbound and westbound segments of State Routes 60 and 91 through State Route 57 are used. Both directions of the five highway segments depicted in Figure 2 make up the ten routes used in this study.

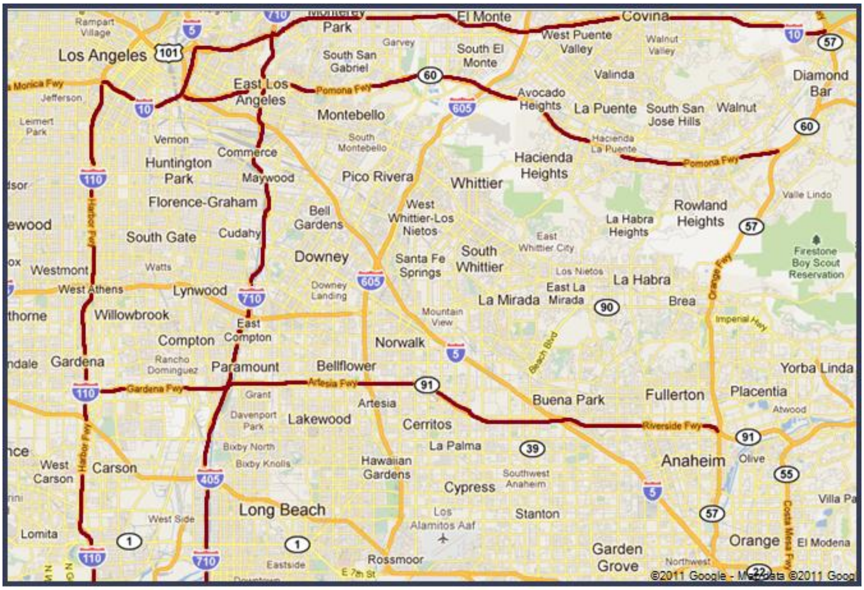

Figure 2. California Highways: I-110, I-710, I-10, SR-60, and SR-91. Adapted from Google Maps. Copyright 2011 by Google.

Data. The majority of the data used in this research came from the California Department of Transportation (Caltrans) Freeway Performance Measurement System (PeMS). Spanning from January 1, 2007 through June 30, 2011, weekly data of incidents, vehicle-miles traveled (VMT), and truck vehicle-miles traveled (Truck VMT) were gathered for each of the ten routes. To clarify, incidents can involve any combination of vehicles and/or trucks and include any severity, injury and non-injury.

Using this data, an independent variable was generated to estimate the percentage of total vehicles on each highway that are trucks. The Truck Percentage variable was calculated for each weekly observation by dividing VMT by Truck VMT and multiplying by 100, as shown below.

$$\text{Truck Percentage} = (\text{Truck VMT} / \text{VMT}) \times 100.$$

Table 1 contains a brief description of summary statistics. A detailed list of summary statistics for each highway segment can be found in Table A1 of the Appendix.

Table 1
Brief Summary Statistics

Variable	M	SD
Accidents (weekly count)	42.24	14.39
Truck VMT (thousands of truck-miles)	774.16	236.21
VMT (millions of vehicle-miles)	15.77	3.72
Truck Percentage (of total traffic volume)	4.94%	1.10%
Number of Observations per Highway	235	
Total Number of Observations	2350	

The remaining data consists of gas prices gathered from the Federal Reserve Bank of St. Louis Economic Database. These weekly gas prices make up the Gas variable that is used as a measure of economic wellness. Dummy variables for each highway route in both directions were generated as well as for the two Clean Truck Program enforcement dates. The first CTP enforcement date represents the ban placed in October 2008 and the other enforcement date of January 2010 corresponds to the second set of restrictions.

Model. The dependent variable in the model is classified as count data because the observations are non-negative integer values that count the number of weekly accidents. Accordingly, a count model is used to estimate the count data of weekly accidents on a given highway. A Poisson model is a typical count model used to estimate count data and assumes the mean of the count variable is equal to its variance. However, as found in Table 1, a Poisson regression cannot be used because the mean of the accidents variable, 42.24, is less than its variance of 207.04, which is also equal to the square of its standard deviation of 14.39.

A variable whose mean is less than its variance is known as an overdispersed variable. As previously shown, the dependent variable of weekly accident counts is overdispersed with a mean less than its variance. Therefore, an appropriate count model to use is a generalization of the Poisson model known as the negative binomial model, which models count variables that are typically overdispersed. An exposure variable controls for the fact that counts may occur over different observation periods (Statistical, 2007). Therefore, an exposure variable of VMT was used since each highway has a different amount of vehicle-miles traveled in a given week. For example, a count of 15 accidents in a given week is different on a highway with 100,000 VMT versus a highway with 20,000,000 VMT.

The dependent variable of weekly accidents is modeled using the independent variables of Truck Percentage and Gas, the dummy variables representing each highway and the CTP enforcement dates, and an exposure variable of the VMT variable.

Results

The negative binomial regression coefficients are reported as an incidence rate ratio (IRR) to provide a more appropriate interpretation. An IRR greater than one translates to an increase in the estimated accident risk, and an IRR less than one represents a decrease in the risk of an accident. The IRRs, standard errors, test statistics and corresponding p-values are reported in Table 2. IRR interpretations are relative to the westbound segment of Interstate 10 (I-10 W), which was arbitrarily chosen as a point of reference for comparison among other highway segments. For example, the IRR in Table 2 that corresponds to the eastbound segment of State Route 91 (SR-91 E) estimates it to be less dangerous than the I-10 W segment. Specifically, the IRR of 0.894 that corresponds to SR-91 E estimates the risk of an accident occurring on SR-91 E to be 10.6% lower than the risk of an accident on I-10 W. Similarly, the IRR of 1.132 estimates the northbound segment of Interstate 710 (I-710 N) to be 13.2% more dangerous than I-10 W.

As hypothesized, the drayage routes, Interstates 110 and 710, are found to be more dangerous than nearly all of the other highway segments analyzed. The highway directly serving the Port of Long Beach, Interstate 710, is the most dangerous when compared to the rest of the highways. Although the highway serving the Port of Los Angeles, Interstate 110, is less dangerous than I-10 W, it was found to be more dangerous than the remaining highways. A list of highway rankings in order from most dangerous to least is found in Table A2 of the Appendix.

The IRR corresponding to the Truck Percentage variable reports a 2.7% increase in weekly accident rates resulting from a one percentage point increase in the truck concentration on a highway. Thus, an increase in the truck percentage of total traffic on a highway is expected to increase the risk of an accident signifying a positive relationship between accidents and truck concentration. The Gas variable used to control for economic conditions reports an expected IRR less than one that estimates a 3.6% decrease in accident risk for every $1 increase in the price of gas. Intuitively, as gas prices increase, fewer vehicles on a highway make an accident less likely to occur.

The main focus of this analysis revolves around the CTP enforcement dates. The IRR of the first enforcement date of October 2008 shows an initial decrease in accident rates by 7.4%. However, the IRR of the latest enforcement date of January 2010 reports an overall increase in accident rates by 7.2%. An initial decrease in accident rates followed by an increase in accident rates suggests the CTP had no significant change in accident rates on the highways analyzed. This result is important as it signifies the CTP did not improve safety on its neighboring highways. Both of the CTP enforcement date variables are statistically significant at the 1% level. Additionally, all of the variables are statistically significant at the 10% level, and all of the variables are statistically significant at the 1% level excluding both I-110 variables.

Table 2
Weekly Accident Rate Negative Binomial Regression Output

Variable	IRR	SE	t-Stat.	p-Value
Truck Percentage	1.027	.009	2.91	.004
Gas	0.964	.012	-3.06	.002
OCT 2008	0.926	.015	-4.75	.000
JAN 2010	1.072	.017	4.28	.000
I-110 N	0.943	.023	-2.41	.016
I-110 S	0.958	.023	-1.78	.075
I-710 N	1.132	.029	4.77	.000
I-710 S	1.103	.028	3.92	.000
SR-91 E	0.894	.022	-4.50	.000
SR-91 W	0.885	.023	-4.69	.000
SR-60 E	0.746	.023	-9.47	.000
SR-60 W	0.635	.019	-15.33	.000
I-10 E	0.897	.021	-4.26	.000

Limitations & Further Research

The data processing algorithms that PeMS uses are based on empirical models that are fitted to historical data. Any mistakes in the algorithms predictions may create error in the estimations. Furthermore, the single loop detectors that PeMS uses to compute data are also susceptible to failure. Additionally, the amount of highway containing these detectors does not always cover the entire route analyzed. Conclusively, the data from PeMS may not be as reliable as other sources, such as the Caltrans Traffic Accident Surveillance and Analysis System (TASAS).

Indeed, collecting car and truck volume data directly from Caltrans and accident data directly from TASAS for each route would be an improvement for further research (Steimetz, Yamarik, & Malatesta, 2011). Another improvement to the model used in this study would be to control for more variables that may affect traffic and accident data. Controlling for weather using precipitation data or controlling for weeks that contain holidays may also improve the model used in this study.

Conclusion

Deregulation of the transportation industry resulted in free entry into the drayage market and the highly competitive sector is now composed of a majority of independent owner operators. These dray drivers work long hours making little profit and often times cannot afford to properly maintain their trucks. Some drivers resort to unsafe and illegal practices, along with eluding enforcement officers. Thus, independent owner operators have recently been under scrutiny and been labeled as dangerous drivers. The Clean Truck Program is thought to alleviate the situation by improving safety measures and by reducing the number of older trucks serving the Port of Los Angeles and the Port of Long Beach.

After analyzing weekly traffic and accident data from California highways containing heavy drayage traffic coming from the San Pedro Bay Port complex, no evidence was found to support the dangerous label given to dray drivers. This conclusion is made because no significant change in accident risks was found on these highways after the Clean Truck Program's implementation and removal of older trucks serving the SPB Ports. The Clean Truck Program's role in the decrease of competition did not appear to have improved safety on drayage routes, possibly dispelling the myth of dangerous independent owner operators. However, as expected, the highways directly serving the Port of Long Beach and Port of Los Angeles, Interstates 710 and 110, were found to be among the most dangerous routes analyzed.

The San Pedro Bay Ports Clean Truck Program has been used as an example in the development of similar port drayage programs by other U.S. ports. Although this program is currently being implemented at the San Pedro Bay Port, it is also being considered at other ports to address the challenges of the drayage trucking industry, and therefore the conclusions are relevant to a much broader set of ports (Goodchild & Mohan, 2008, p. 408). Consequently, further research will be conducted using a more efficient form of data collection from the California Department of Transportation Traffic Accident Surveillance and Analysis System.

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Appendix

Table A1
Summary Statistics

Highway Variable	M	SD
I-110 N		
Accidents (weekly count)	41.90	10.43
Truck VMT (thousands of truck-miles)	574.02	43.27
VMT (millions of vehicle-miles)	15.40	0.66
Truck Percentage (of total traffic volume)	3.73%	0.23
I-110 S		
Accidents (weekly count)	35.91	10.04
Truck VMT (thousands of truck-miles)	521.95	58.04
VMT (millions of vehicle-miles)	12.90	0.65
Truck Percentage (of total traffic volume)	4.04%	0.38
I-710 N		
Accidents (weekly count)	34.52	9.16
Truck VMT (thousands of truck-miles)	541.23	88.12
VMT (millions of vehicle-miles)	10.13	0.58
Truck Percentage (of total traffic volume)	5.33%	0.74
I-710 S		
Accidents (weekly count)	33.31	10.15
Truck VMT (thousands of truck-miles)	502.73	130.98
VMT (millions of vehicle-miles)	10.13	0.53
Truck Percentage (of total traffic volume)	4.95%	1.18
SR-91 E		
Accidents (weekly count)	44.95	11.38
Truck VMT (thousands of truck-miles)	866.73	71.71
VMT (millions of vehicle-miles)	16.77	0.66
Truck Percentage (of total traffic volume)	5.17%	0.34

SR-91 W		
Accidents (weekly count)	45.17	11.58
Truck VMT (thousands of truck-miles)	933.86	69.06
VMT (millions of vehicle-miles)	16.87	0.73
Truck Percentage (of total traffic volume)	5.54%	0.34
SR-60 E		
Accidents (weekly count)	37.46	10.28
Truck VMT (thousands of truck-miles)	1049.26	113.27
VMT (millions of vehicle-miles)	16.27	1.35
Truck Percentage (of total traffic volume)	6.45%	0.47
SR-60 W		
Accidents (weekly count)	34.14	9.61
Truck VMT (thousands of truck-miles)	1077.10	172.33
VMT (millions of vehicle-miles)	17.50	1.30
Truck Percentage (of total traffic volume)	6.15%	0.84
I-10 E		
Accidents (weekly count)	53.74	13.24
Truck VMT (thousands of truck-miles)	774.42	116.61
VMT (millions of vehicle-miles)	20.77	1.18
Truck Percentage (of total traffic volume)	3.72%	0.48
I-10 W		
Accidents	61.30	16.19
Truck VMT (thousands of truck-miles)	900.26	113.74
VMT (millions of vehicle-miles)	20.96	1.40
Truck Percentage (of total traffic volume)	4.29%	0.39
All Highways		
Accidents (weekly count)	42.24	14.39
Truck VMT (thousands of truck-miles)	774.16	236.21
VMT (millions of vehicle-miles)	15.77	3.72
Truck Percentage (of total traffic volume)	4.94	1.10
Number of Observations per Highway	235	
Total Number of Observations	2350	

Table A2
Highway Ranking

Highway	Rank (% Dangerous)
I-710 N	13.2% More Dangerous
I-710 S	10.3% More Dangerous
I-10 W	---
I-110 S	4.2% Less Dangerous
I-110 N	5.7% Less Dangerous
I-10 E	10.3% Less Dangerous
SR-91 E	10.6% Less Dangerous
SR-91 W	11.5% Less Dangerous
SR-60 E	25.4% Less Dangerous
SR-60 W	36.5% Less Dangerous

Note. Highway comparisons are relative to I-10 W.

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