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A Firm Size and Safety Performance Profile of the U.S. Motor Carrier Industry

tech transfer summary

November 2015

RESEARCH PROJECT TITLE

How Firm Size Affects Safety Performance in the U.S. Motor Carrier Industry

SPONSORS

Midwest Transportation Center
U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology (USDOT/OST-R)

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The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the project sponsors.

This study presents an initial profile of the relationship between firm size and safety performance in the U.S. motor carrier industry.

Background

Motor carrier crashes continue to present a societal and public policy problem. Large commercial truck crashes are a topic of serious concern in Iowa. Statistics illustrate the need to make further progress on the safety performance of motor carriers.

Problem Statement

While previous studies have shown that driver characteristics affect driver involvement in reportable crashes, scant attention has been paid to how the size of the carrier affects crash rates. Previous research has not developed a truck crash prediction model with a particular focus on the size of the carrier.

Objectives

The purpose of this study was to develop a driver-focused truck crash prediction model with a particular focus on the size of the carrier that the driver is associated with at the time of a state reportable crash. To the extent that we can shed light on some of the factors that contribute to motor carrier crashes, we hope to provide insights into how motor carrier firms, employees, and public policy officials can implement changes to mitigate these safety issues.

Research Description

We developed a unique database of motor carrier firms based on the latest available data at the time of the study. The database provides a rich source of information on several carrier characteristics as well as safety performance metrics.

The firm safety database was derived from the Federal Motor Carrier Safety Administration (FMCSA) Motor Carrier Management Information System (MCMIS) and Safety Measurement System (SMS) data from Volpe, The National Transportation Systems Center (which is part of the U.S. Department of Transportation (DOT)).

The sample included all interstate motor carriers in the FMCSA MCMIS and the FMCSA Compliance, Safety, Accountability (CSA) program 2010 databases as of June 2014. The database included 462,725 firms for which complete data was available for all the variables in the models in the scope of this study.

The SMS relies on information collected from the following comprehensive data sets: (1) commercial vehicle crash data, reported by states to FMCSA, (2) data collected from individual compliance reviews, (3) data from roadside inspections including violations, (4) data from closed enforcement cases, and (5) MCMIS Census File data on individual carriers, including their type of operations and fleet size.

Our preliminary safety profile analysis began by examining firm safety performance across discrete categories of firm size. We analyzed commercial driver and vehicle out-of-service violation rate patterns, crash rates, and Behavior Analysis Safety Improvement Category (BASIC) measure scores by firm size.

The seven BASICs are as follows: unsafe driving, crash indicator, hours-of-service (HOS) compliance, vehicle maintenance, controlled substances/alcohol, hazardous materials (HAZMAT) compliance, and driver fitness.

Briefly, the FMCSA CSA program uses the SMS to analyze data from roadside inspections, crash reports, and investigation results. Carriers are then grouped into the BASIC with other carriers that have a similar safety profile, and then the SMS ranks carriers accordingly.

Next, the analysis turned to examining the 11 most active carrier commodity segments and focused on how several of the commodity segment categories are related to safety performance.

Most active commodity segments in dataset

- | | |
|-----------------------|---------------------------------|
| 1. General Freight | 7. Logs, Poles, Beams, Lumber |
| 2. Other | 8. Motor Vehicles |
| 3. Construction | 9. Farm Supplies |
| 4. Building Materials | 10. Metal, Sheets, Coils, Rolls |
| 5. Machinery | 11. Fresh Produce |
| 6. Grain, Feed, Hay | |

Other commodity segments in dataset

- | | |
|----------------------------|---------------------------|
| 12. Paper Products | 22. Meat |
| 13. Refrigerated Food | 23. Oil Field Equipment |
| 14. Commodities Dry Bulk | 24. Utility |
| 15. Livestock | 25. Intermodal Containers |
| 16. Household Goods | 26. Chemicals |
| 17. Garbage, Refuse, Trash | 27. U.S. Mail |
| 18. Beverages | 28. Coal, Coke |
| 19. Passengers | 29. Mobile Homes |
| 20. Drive Away/Tow Away | 30. Water Well |
| 21. Liquids/Gases | |

We examined the driver and vehicle out-of-service rates first and then each of the seven BASICs.

The ownership/equipment profile part of the analysis began by examining firm safety performance across four distinct quartile categories of fleet ownership.

Tractor and trailer fleet ownership profile

Fleet Ownership Group	Tractor or Trailer Ownership	Number of Firms	Percent of Firms
1	0% to 25%	116,019	8.56
2	>25% to ≤50%	484,046	35.7
3	>50% to ≤75%	119,805	8.84
4	>75% to ≤100%	636,127	46.91

Group 1 represented firms that own between 0 and 25 percent of their tractors or trailers; group 2 represented firms that own greater than 25 percent and less than or equal to 50 percent of their tractors or trailers; group 3 represented firms that own greater than 50 percent and less than or equal to 75 percent; and group 4 represented firms that own greater than 75 percent and less than or equal to 100 percent. The predominant number of firms in our sample were in groups 2 and 4.

Again, we examined the driver and vehicle out-of-service rates and then each of the seven BASICs.

Finally, we developed a multivariate model using ordinary least squares (OLS) regression analysis. The model examines each of the factors described simultaneously on the safety performance measures contained in the motor carrier database.

Key Findings and Recommendations

The U.S. motor carrier industry continues to be dominated by very small firms. More than 700,000 firms in the U.S. motor carrier industry contain one power unit. This trend reflects how the barrier to entry into the industry remains very low and how presumably the industry is attractive to new motor carrier entrants, including independent owner-operators.

Larger firms are involved in fewer driver and vehicle out-of-service violations than smaller firms. This finding is further borne out by our multivariate models.

Surprisingly, we discovered that as firm size increases, crash rates increase. This finding needs to be explored further because we discovered that firm size contributes to higher crash rates up until a certain peak. Moreover, we found an inverse relationship. It is quite plausible that there is a curvilinear relationship between firm size and crash rates.

We found an inverse relationship between firm size and the hours of service, vehicle maintenance, and the seven crash BASIC measure scores. This finding was further demonstrated in several multivariate models.

Firm resources are important to motor carriers that recognize the critical importance of safety performance. We believe that larger firms can leverage the financial resources to invest in safety practices and technologies necessary for the monitoring, management, and enforcement of sound safety behavior.

The next important determinant that we explored was the relationship between carrier commodity segments and safety performance. Several competitive market segments exist in the U.S. motor carrier industry. We explored the extent to which firm participation in competitive markets (i.e., commodity segments) contributes to firm safety performance. Our first finding was that several carriers participate in multiple commodity segments.

Focusing our analysis on 11 of the most active commodity areas, we found substantial evidence of statistically significant mean differences in safety performance across several commodity segment areas. We found similar findings in 48 of the 55 vehicle out-of-service rate commodity segment mean difference areas. We found mixed relationships regarding how commodity segment participation affects safety performance in our multivariate analysis.

Collectively, these findings highlight the competitive intensity in the U.S. motor carrier industry. Future research should explore the extent to which firms are making trade-offs between the competitive intensity of the industry and firm safety performance.

The last important factor that we explored in our safety analysis was firm ownership of their tractors or trailers. We first discussed the fleet ownership analysis regarding the driver and vehicle out-of-service rate dependent variables. Generally speaking, up until a certain level of fleet ownership, our results showed that as ownership of equipment percentages increase, safety performance decreases.

Turning to the unsafe driving and HOS BASIC means differences analysis, generally speaking, we found that as firm equipment ownership percentages increase, firm safety performance improves. Results from the multivariate analysis corroborated this finding.

Overall, we found that as fleet ownership percentages increase, the vehicle maintenance BASIC safety performance metrics become worse. This finding appeared consistent in both the means differences and multivariate analysis.

This was a surprising finding because of the critical importance of fleet maintenance to safety performance.

Next, driver fitness is a serious topic in the U.S. motor carrier industry. The driver fitness BASIC is a rating of the firm's commercial motor vehicle (CMV) drivers who are unfit to operate a CMV due to lack of training, experience, or medical qualifications. Anecdotal evidence points out that many commercial drivers are not physically fit to operate a CMV because the employee could suffer from medical issues such as sleep apnea among other issues.

Our means differences and multivariate results showed how as fleet ownership percentages increase, firms perform poorly on the driver fitness BASIC.

This finding highlights how firms need to take more proactive action to improve the health and well-being of their drivers.

We then discussed our findings related to fleet ownership and the HAZMAT BASIC. In four of the size mean difference groups, we found that as ownership percentages increase, HAZMAT BASIC performance becomes worse. This finding was also consistent with the multivariate analysis.

It is quite possible that firm ownership of their equipment serves a more prominent role in the hazardous goods commodity segment. Future research should explore the reasons why firm ownership is not mitigating safety concerns as it relates to this BASIC.

Finally, we explored the relationship of firm ownership percentages and the crash BASIC. We did not find a consistent pattern across percent fleet ownership and safety performance. It appears that firms that own 50 to 75 percent of their fleet have lower crash rates than those that own less than 25 percent of their fleet.

This trend would suggest that owners of their equipment exhibit a strong interest in not exposing their assets to situations in which their property and equipment can be seriously damaged. Clearly, future research is needed to explore this finding in more detail.

Future Research

Our findings highlight how there is tremendous potential for an in-depth analysis of how motor carrier size affects safety performance. We identified three exciting future research opportunities and are currently continuing this work:

- Safety Performance Analysis of Carrier Use of Owner-Operators versus Company Drivers
- Linkage between Competitive Dynamics of U.S. Motor Carrier Industry and Firm Safety Performance
- Analysis of the FMCSA New Entrant Program and Safety Performance: Is the New Entrant Program Working?

Implementation Readiness and Benefits

Generally speaking, smaller carriers do not have the resources to invest in monitoring and implementing sound safety practices to ensure safe operations in the U.S. motor carrier industry. This represents a significant problem because the majority of carriers in the industry are small carriers.

Because there are challenges associated with monitoring the safety performance of carriers in the industry, the FMCSA can benefit from a firm-size safety prediction model that can facilitate the targeting of the carriers that most seriously violate U.S. DOT rules and regulations.

This initial study helped to begin to enhance the understanding of how the characteristics of carriers contribute to driver involvement in state reportable crashes.