Owner-Operator versus Company-Driver Safety Performance Analysis

Final Report
January 2016

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16. Abstract

The safety performance of motor carriers is a serious concern in the trucking industry and is a top priority for the U.S. Department of Transportation. This study explored the extent to which a carrier's use of owner-operators and/or company drivers affects safety performance.

Two primary research questions were addressed: how does motor carrier firm size relate to organizational flexibility, or the use of owner-operators versus company drivers, and does organizational flexibility affect safety performance? The study also examined whether safety performance varies by industry segment.

A dataset based on data obtained for a previous study was created that includes equipment ownership profile information for approximately 108,780 motor carriers. An analysis of the data indicated that the larger the firm, the lower the use of company drivers; contrary to expectations, the use of company drivers results in poorer safety performance; and safety performance varies by industry segment.

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OWNER-OPERATOR VERSUS COMPANY-DRIVER SAFETY PERFORMANCE ANALYSIS

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Principal Investigator
David E. Cantor, Associate Professor
College of Business, Supply Chain and Information Systems, Iowa State University

Research Assistant
Matthew Tekippe
College of Business, Supply Chain and Information Systems, Iowa State University

Author
David E. Cantor

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A report from
Institute for Transportation
Iowa State University
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
Phone: 515-294-8103
Fax: 515-294-0467
www.intrans.iastate.edu

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1. INTRODUCTION

On May 22, 2015, a semi-trailer truck was traveling westbound on Interstate 80 near Iowa City, Iowa, when it crashed into a bridge and became engulfed in flames (Carlson 2015). Tragically, one person was seriously hurt and another individual died as a result of injuries sustained from the accident.

Across the US in 2013, there were more than 3,800 fatal crashes and 385,000 non-fatal crashes that involved at least one large truck or bus (FMCSA 2015). While the Federal Motor Carrier Safety Administration (FMCSA) has implemented and enforced safety practices to reduce the number and severity of accidents, clearly there is a substantial amount of additional work that needs to be pursued to improve the safety performance of firms in the US motor carrier industry.

Safety is a serious concern in the trucking industry. It is of paramount importance that industry and government representatives find ways to make progress on the safety performance of motor carriers. Indeed, safety is a top priority in the U.S. Department of Transportation (DOT) 2012–2016 strategic plan (U.S. DOT 2012).

This study seeks to enhance our understanding of how the FMCSA can continue to improve the safety performance of commercial motor carriers by exploring the extent to which a carrier's use of owner-operators and/or company drivers affects safety performance (e.g., state-reportable crashes).

A steady stream of research has examined several factors that affect motor carrier safety performance. For example, Cantor et al. (2015) found that firm size is positively related to safety performance. Cantor et al. (2009) examined the use of electronic logbooks and found that they have a positive effect on safety performance. Corsi et al. (2014) found that unionized carriers have a positive effect on carrier safety performance because of the provision of safety and health provisions in unionization agreements.

The motor carrier literature has also explored the topic of company drivers and owner-operators. From a driver-level perspective, Cantor et al. (2013) directly compared owner-operators to employee drivers and showed that owner-operators experience poorer safety performance compared to employee drivers. However, Cantor et al. (2013) found that, surprisingly, employee drivers are involved in more crashes than owner-operators. Further research is needed to understand how motor carriers are affected by the use of owner-operators because the type of driver directly affects the firm's safety performance. This study took a further step to explore this issue from a firm-level perspective.

We identified that a truck crash prediction model with a particular focus on the use of owner-operators and employee drivers does not exist in the literature. A firm-based owner-operator and employee driver safety model is needed so that the FMCSA can understand the importance of providing additional safety management resources to motor carriers that are heavily reliant upon owner-operators.

To explore this issue, based on data from a larger study (Cantor et al. 2015), we created a dataset that contains equipment ownership profile information that could be used to explore the owner-operator and company driver research question.

The topic of the use of owner-operators and company drivers is timely for several reasons. First, there is a serious shortage of qualified commercial motor vehicle drivers (Ferro 2015). Second, the motor carrier industry is highly competitive, and firms seek to adopt organizational strategies to remain flexible to meet customer needs.

One important strategy is the outsourcing of firms' driver and commercial motor vehicle equipment needs to third-party logistics providers in order to respond to customer pressure for capacity.

Therefore, the specific focus of this study was on two important research questions. First, how does firm size relate to organizational flexibility (e.g., adoption of owner-operators or company drivers)? Second, does organizational flexibility (e.g., use of company drivers or owner-operators) affect safety performance?

We adopted theoretical frameworks from the industrial organizational economics literature to explore our research questions. The next chapter provides a detailed discussion of our theoretical frameworks.

2. THEORETICAL FRAMEWORKS: ORGANIZATIONAL FLEXIBILITY AND TRANSACTION COST ECONOMICS

2.1. Organizational Flexibility

The initial theoretical basis for this study was the organizational flexibility literature. In today's global economy, firms seek supply chain strategies that can help them to respond to demand and supply shocks that ultimately affect their ability to meet customer demand. An important supply chain strategy that firms increasingly are pursuing is organizational flexibility.

Organizational flexibility arrangements traditionally include contract manufacturing, alternative work arrangements (e.g., temporary workers), and strategic alliances (Cheng et al. 2014, Schilling and Steensma 2001). Firms derive several benefits from organizational flexible arrangements, including the ability to more easily adapt to changes in the internal and external environment, source non-core resources from supply partners (Afuah 2003), and thus focus on core business activities (Cheng et al. 2014, Schilling and Steensma 2001). Operating in complex supply chain networks, firms seeks governance arrangements that enable them to rapidly reconfigure how they conduct business with both upstream and downstream supply chain partners.

Firms are motivated to pursue organizationally flexible arrangements for several reasons. First, firms frequently need to manage a variety of unrelated products and/or commodities for their customers. The focal firm faces uncertainty when customer demand patterns are unpredictable and thus create a need for the firm to engage in outsourcing or third-party relationships with its suppliers as a way to respond to an instability in the external environment.

Indeed, in the US motor carrier industry, trucking companies face high levels of demand uncertainty and, relatedly, cargo movement uncertainty. Because of the pressure that trucking firms face to respond to unexpected customer demands, motor carriers often turn to owner-operators as way to increase/decrease carrying capacity and gain access to specialized transportation equipment.

Likewise, the use of owner-operators (e.g., contractual relationships) provides the focal firm with access to technologies and services that it ordinarily would not possess. In this way, the organizationally flexible arrangement enables the motor carrier to retain and/or increase its customer base.

A second motivating factor that causes firms to pursue organizationally flexible arrangements is geographic reach (Cheng et al. 2014). A complex geographic network can be defined as a situation where there are many supply chain locations that need to be serviced and subsequently require management between the ultimate customer and the original manufacturer.

Because of the many links in the supply chain, firms typically tend to increase their safety stock levels to guard against stockouts that arise because of unexpected delays in the replenishment of cycle stock (i.e., shipment uncertainty). System-wide coordination is needed to mitigate out-of-stock situations.

As a result, firms turn to third-party providers to help them mitigate the complexity of managing longer supply chains, which involves the management of a network of transportation terminals. Indeed, the use of owner-operators can assist the focal firm with adding capacity in geographically dispersed locations.

A third factor that motivates a firm to pursue organizational flexibility is scale economies (Cheng et al. 2014). Because of the uncertainty in the global economy, focal firms need access to vast resources to source, manufacture, and distribute goods to multiple geographic regions in the world. Larger motor carrier firms have an advantage over smaller carriers because they can generate the economics of scale across logistics and transportation services (Cheng et al. 2014).

In the motor carrier industry, larger firms have the resources to partner with other logistics and transportation firms to manage these complex supply chain structures. Larger firms have the financial resources to invest in technologies such as the enterprise resource planning (ERP) systems provided by many vendors, including Systems, Applications & Products (SAP) in Data Processing and Oracle. Indeed, several third-party logistics providers are making investments in enterprise transportation management systems such as the Oracle Transportation Management (OTM) software provided for better transportation order management (Oracle 2015).

2.2. Transaction Cost Economics

We now turn to enhancing our organizationally flexible perspective by integrating the transaction cost economics (TCE) framework. The TCE framework was developed to provide an explanation about the factors that cause firms to either vertically integrate the factors of production (e.g., internally manufacture a product or services) or to outsource to the external market (e.g., procure required transportation assets and services).

This framework was developed by Williamson (1975) to better understand the motivation of a firm to pursue the ideal form of governance. Although the TCE framework has been extensively used in fields such as marketing, finance, and economics, to the best of our knowledge this theoretical lens has not been extensively used in transportation research.

The TCE literature points out, there are two prominent assumptions that affect a firm's decision to make or buy products and services. The first assumption is known as *bounded rationality*.

According to Williamson (1985), managers have a finite capacity to process information about the internal operations of the firm as well as limited bandwidth to monitor the behavior of external supply chain partners. When working with external partners, Williamson (1985) suggests that firms cannot specify a complete contract to guard against irrational behavior or unanticipated circumstances that could impact the supply chain partner's ability to deliver products and services on a timely basis.

Thus, the second assumption in the TCE framework is *opportunism*. Williamson (1985) notes that people and firms sometimes do not take actions that are in the best interests of others and/or the focal firm.

The TCE framework also posits that there are three factors that determine the transaction-specific investments that a firm makes in the preferred governance structure of the firm (e.g., in the context of our study, the use of owner-operator and/or company drivers).

The first determinant is asset specificity. Asset specificity is defined as the degree to which resources or assets that the firm creates can be readily sold in the open market (Williamson 1985). For example, if a firm believes that leasing transportation information technology systems from an outside vendor will not cause the firm irrevocable harm, the firm will buy (or lease) the software technology from the open market rather than build it internally. Otherwise, the firm will make transaction-specific investments to support the development of software technology within the boundaries of the firm. Indeed, some third-party logistics providers are creating information technology (IT) consulting services surrounding the transportation management of a shipper's freight management needs (Ruan 2015).

The second determinant is uncertainty and is defined as a lack of knowledge about the state of the future (Shin 2003). Firms exist to guard against various forms of uncertainty that exist either internally or externally. Some examples of uncertainty include behavioral uncertainty and environmental uncertainty (Williamson 1985).

Behavioral uncertainty refers to opportunistic situations that arise due to human nature in the context of the business partnership between a focal firm and its supply chain partner. Behavioral uncertainty is created because one supply chain partner may deliberately distort information that it sends to the other partner firm (e.g., an owner-operator not accurately reporting hours of service (HOS) data, shipment location information, or equipment condition of the fleet).

Environmental uncertainty is defined as unexpected changes in country, industry, firm, or product conditions (Shih 2003). For example, a firm could unexpectedly experience a plant fire, which would impact supply chain continuity. There could also be weather-related events that impact delivery services. Relatively recently, there was also a great deal of uncertainty surrounding the labor port strike in Los Angeles, California (Rogers 2013).

The third determinant is the frequency or volume of the transaction (Williamson 1985). Similarly to the other determinants discussed, the firm evaluates its preferred governance mode by analyzing the extent to which it conducts a high volume of transactions with its supply chain partners.

If there is a sufficient volume of transactions with its customers, the firm becomes motivated to make the product internally. The firm selects this option because it cannot afford to be held hostage by its supply chain partner (Williamson 1985).

Likewise, if the firm believes it has a short-term need for a value-added component or service, it will become motivated to source the product from the market. The firm thus makes its cost-benefit decision based on the investment required to build internal capabilities against the risk of its supply chain partners acting opportunistically.

Depending on these three factors, a firm may decide whether to make or buy a product/service. The outcome itself is “make” or “buy” rather than the firm’s performance.

2.3. Hypotheses

We utilize the organizational flexibility and transaction cost economics framework to guide the development of our three core hypotheses, which are presented below. An assumption of the theoretical framework is that the decision to use company drivers over owner-operators is primarily conceptually linked to the concept of organizational flexibility.

Higher use of company drivers (use of company-owned equipment) suggests that the firm utilizes the market for fewer resources. Following this logic, then, we develop our first hypothesis, that firm size is a determinant to use of company drivers (e.g., use of company-owned equipment). We then present our second hypothesis, that higher use of company drivers affects firm safety performance. Lastly, we present our final hypothesis that the effect of company drivers on firm safety performance varies across industry commodity segments.

2.3.1. Firm Size and Company Drivers

The first factor in our model is the size of the firm. Because of the scale of economies, larger firms have a strong desire to pursue more flexible operating strategies. Larger firms can spread the costs associated with monitoring internal and external entities against opportunistic behavior across its vast size. Indeed, larger firms have the financial and human resources that can be used to make investments in information technology solutions to monitor the driver behavior of its contractors (e.g., owner-operators) that operate across geographic boundaries.

In the US motor carrier industry, trucking companies have made investments into electronic logbook technology as a means to enforce the HOS regulations. Indeed, Cantor et al. (2009) found that the greater the adoption of electronic logbooks, the less frequently the carrier was involved in HOS violations and motor carrier crashes.

Following this logic, larger firms have the financial resources to invest in electronic logbook solutions and thus minimize the likelihood of damage to their products that are transported by owner-operators. Similarly, Cantor et al. (2008) also point out that several motor carrier firms are adopting global positioning system (GPS) devices to help monitor the location of their freight, thus reducing the necessity for the carriers to own the physical assets to track their locations.

Larger firms prefer to outsource vehicle maintenance responsibilities. Larger firms may prefer to adopt an owner-operator strategy because the focal firm does not have to bear the burden of vehicle maintenance and is looking for ways to reduce the expense of vehicle upkeep (Kilcarr 2015). Moreover, through outsourcing arrangements the firm gains access to modern equipment, which can reduce safety concerns.

Several other flexible operating strategies are emerging in the US motor carrier industry. Over the past several years, J.B. Hunt Transportation has been partnering with the US railroad industry to route its freight using intermodal strategies. By leveraging the increased flexibility that rail transport offers, J.B. Hunt Transportation is able to provide higher levels of on-time delivery services to its customers.

Larger firms seek additional transportation delivery options for the movement of freight because of the ongoing shortage of truck drivers. Access to owner-operators provides larger motor carriers with an additional option to respond to dynamic changes in customer demand.

In situations of high demand, larger firms can rapidly gain access to available truck capacity using owner-operators. Conversely, when economic conditions deteriorate, motor carriers can quickly scale down their own capacity by not sourcing owner-operators or even by utilizing intermodal services. Indeed, Birkland (2015) points out that "[c]oming off an economic slump, some fleets—who may be wary of investing in new trucks—are now leasing equipment to handle increased shipping demands." Following this logic, we present our first hypothesis:

Hypothesis 1: The larger the firm, the lower the use of company drivers.

2.3.2. Use of Company Drivers and Firm Safety Performance

The next factor in our model focuses on the relationship between the use of company drivers and firm safety performance.

Firms pursue flexible operating arrangements in order to reduce their operating costs and thus improve their financial performance. Indeed, Cheng et al. (2012) show that contract manufacturing (e.g., outsourcing) leads to improved inventory performance. The authors explain that contract manufacturing, a form of flexible operating arrangement, enables the firm to pool the capacity of a supplier's manufacturing capabilities at a lower cost, which thus leads to the improved operating efficiency of the focal firm. Thus, focal firms derive improved operating efficiency when utilizing flexible arrangements.

Organizationally flexible arrangements can also contribute to improved safety performance. First, firms may outsource their transportation needs to third parties that specialize in motor carrier safety management practices. Thus, the outsourced provider reduces the safety risk exposure of the focal firm. Relatedly, the outsourced provider may have invested in appropriate transportation equipment that is designed to haul the focal firm's products. In so doing, the outsourced provider maintains modern equipment that is safe to use to meet the specialized transportation needs. Indeed, modern commercial trucks have collision avoidance technologies that shut down the truck when it is about to collide with another vehicle (Cantor et al. 2008).

Lastly, the outsourced provider may have stronger driver capabilities to meet the delivery and time requirements of the focal firm's customers. Indeed, some motor carriers utilize driver teams to transport freight.

However, there are several reasons to believe that organizational flexibility may result in poorer safety performance. As discussed in the theoretical framework chapter, firms internalize the factors of production in situations where the organization believes there are potential problems with opportunistic behavior. In the context of the US motor carrier industry, several opportunities for risky behavior can cause harm to the firm.

The first potential area of risk for the firm is poor driver behavior. When outsourcing trucking operations to an owner-operator or partner transportation firm, the focal firm is exposed to issues of lack of control of driver decision making. Examples of poor driver behavior include HOS violations, drug and alcohol abuse, and poor decisions on the road (e.g., driver distraction). To reduce the risk of these types of decisions, motor carriers may prefer to hire their own drivers and implement improved driving training and random drug and alcohol tests (Cantor et al. 2013).

The second potential area of risk is poor equipment inspection and maintenance. Because commercial vehicles are exposed to harsh operating conditions, it is important to the firm to regularly monitor and maintain their fleet. Firms that own their fleet may have greater incentive to ensure that their equipment is in good working order. In contrast, owner-operators may not have the financial resources to properly inspect and maintain their equipment, which could result in greater exposure to safety performance issues.

While there are positive aspects of outsourcing transportation services, we believe that the downsides overwhelmingly motivate firms to employ a company driver strategy. Based on this logic, we present the second hypothesis:

Hypothesis 2: Higher levels of use of company drivers is positively related to firm safety performance.

2.3.3. Equipment Ownership and Motor Carrier Operating Segment

The last factor in our model concerns the impact of equipment ownership in each of the industry's multiple operating segments. As discussed in Cantor et al. (2015), the US motor carrier industry can be characterized as having several different commodity segments, from markets that are serviced through a network of terminals (less-than-truckload operations) to the delivery of freight between shippers and receivers without the need of break-bulk terminals (truckload operations).

Firms need to respond to varying levels of customer demand across multiple industry segments. Firms that possess flexible operating strategies are able to acquire the specialized trucking assets necessary to haul freight based on the equipment requirements in their respective commodity segments. Due to pressure from their customers, firms that are not easily adaptable may be placed not only at a competitive disadvantage but also in a precarious safety performance situation in handling shipments that they ordinarily don’t have the capability to service.

Stated otherwise, firms may be hauling freight in industry segments in which they lack the appropriate equipment and/or specialized knowledge to do so. It follows that the impact of equipment ownership on safety outcomes would vary across the industry’s operating segments.

Hypothesis 3: The effect of use of company drivers on firm safety performance varies across industry commodity segments.

3. METHODS

As a part of a previous larger study, we constructed a commercial carrier safety database to examine the relationship between organizational flexibility (e.g., use of company drivers or owner-operators) and safety performance in the US motor carrier industry. Because the larger study is described in greater detail in Cantor et al. (2015), we provide a brief overview of the methodology and sample in this section.

The database that was derived for this study was based on data obtained from the Volpe National Transportation Systems Center, which provided data from the Motor Carrier Management Information System (MCMIS). The sample consists of data for approximately 108,780 motor carriers.

Our first dependent safety variable is the driver out-of-service (OOS) rate (Driver_OOS_Rate), which is defined as the number of driver OOS inspections divided by the number of total driver inspections. Our second dependent safety variable is the vehicle out-of-service rate (Vehicle_OOS_Rate), which is the number of vehicle OOS inspections divided by the number of total vehicle inspections. Lastly, we measure crash rate (Crash_Rate) as the total number of crashes the firm's drivers were involved in divided by the size of the firm in terms of the total number of power units (i.e., tractors).

We now describe the key independent variable specified in our models. Similarly to Monaco and Redmon (2012), the use of company drivers was operationalized as the ratio of owned tractors to the total number of owned and leased (term) tractors in a carrier's fleet of vehicles. We use this measure as a proxy of the level of usage of company drivers because company drivers are more likely to operate owned equipment than owner-operators, who typically operate leased equipment.

We also controlled for other important variables, including firm size. Firm size is operationalized as the firm's total number of power units (tractor vehicles). We also controlled for the carrier's operating segment/commodity segment.

4. RESULTS

We now turn to describing our results. We first present our descriptive statistics in Table 1.

Table 1. Descriptive statistics

Variable	N	Mean	Min	Max	Std Dev
Driver OOS Rate	108266	0.0808189	0	1	0.1283226
Vehicle OOS Rate	107843	0.2651457	0	1	0.213352
Crash Rate	108675	0.117178	0	36.5	0.3279672
Firm Size	108675	28.33561	1	98365	428.892
% Owned Tractors	86951	84.333	0	100	32.2316
General Freight	108780	0.500552	0	1	0.500002
Household Goods	108780	0.035668	0	1	0.185463
Building Materials	108780	0.173534	0	1	0.37871
Large Machinery	108780	0.168395	0	1	0.374218
Fresh Produce	108780	0.145128	0	1	0.352231
Intermodal	108780	0.038711	0	1	0.192907
Passenger	108780	0.024425	0	1	0.154367
Dry Bulk	108780	0.091083	0	1	0.287728
Refrigerated	108780	0.136238	0	1	0.343043

As shown, the majority of the sample participates in the general freight, building materials, large machinery, refrigerated produce, and fresh produce industries. On average, the firms in our sample have 28 power units.

We now present the results of our ordinary least squares (OLS) regression models, which were used to test our hypothesized relationships. Hypothesis 1 states that the larger the firm, the lower the use of company drivers. As shown in Table 2, the beta coefficient of firm size is negative and statistically significant at the 0.01 level. Thus, we find statistical support for Hypothesis 1.

Table 2. Impact of firm size on use of company drivers

	Company Drivers
Firm Size	-0.001
	(0.000)**
General Freight	-5.875
	(0.231)**
Household Goods	-4.315
	(0.616)**
Building Materials	-1.528
	(0.289)**
Fresh Produce	3.972
	(0.390)**
Intermodal	-16.231
	(0.519)**
Passenger	-0.556
	(1.493)
Dry Bulk	0.424
	(0.360)
Refrigerated	-5.334
	(0.402)**
Constant	89.039
	(0.171)**
R^2	0.03
N	86,949

* $p < 0.05$
** $p < 0.01$

Next, Hypothesis 2 states that higher levels of use of company drivers is positively related to firm safety performance. The results in Table 3 across all three models show that the use of company drivers results in poorer safety performance. These relationships are statistically significant at the 0.01 level. Thus, we do not find support for Hypothesis 2.

Table 3. Impact of use of company drivers on safety performance

	Driver OOS Rate	Vehicle OOS Rate	Crash Rate
Company Drivers	0.000	0.001	0.000
	(0.000)**	(0.000)**	(0.000)**
Firm Size	-0.000	-0.000	-0.000
	(0.000)**	(0.000)**	(0.000)**
General Freight	0.017	-0.026	0.016
	(0.001)**	(0.001)**	(0.002)**
Household Goods	0.008	-0.027	-0.019
	(0.002)**	(0.004)**	(0.006)**
Building Materials	-0.013	0.009	-0.012
	(0.001)**	(0.002)**	(0.003)**
Fresh Produce	0.010	-0.006	-0.002
	(0.001)**	(0.002)*	(0.004)
Intermodal	-0.015	0.031	-0.005
	(0.002)**	(0.003)**	(0.005)
Passenger	-0.006	-0.053	-0.082
	(0.005)	(0.010)**	(0.015)**
Dry Bulk	-0.012	-0.033	-0.009
	(0.001)**	(0.002)**	(0.004)*
Refrigerated	0.009	-0.028	0.015
	(0.001)**	(0.003)**	(0.004)**
_cons	0.050	0.229	0.088
	(0.001)**	(0.002)**	(0.004)**
R^2	0.02	0.03	0.00
N	86,784	86,359	86,949

* $p < 0.05$
** $p < 0.01$

We test Hypothesis 3 by estimating separate regressions for each of the nine industry segments and including in each regression an interaction term of the industry segment and use of company drivers. We present evidence of the support for Hypothesis 3 by examining the coefficient of the interaction term. A negative and statistically significant coefficient for the interaction term means that the positive effects of the use of company drivers on safety performance is stronger in that industry segment. A positive and statistically significant coefficient for the interaction term means that the positive effects of the use of company drivers on safety is weaker in that industry segment. A summary of our findings is shown in Table 4.

Table 4. Interaction of the use of company drivers and industry segment: impact on safety performance

	Driver OOS Rate	Vehicle OOS Rate	Crash Rate
Company Driver X General Freight	NS	-***	NS
Company Driver X Household Goods	NS	-*	NS
Company Driver X Building materials	NS	-**	NS
Company Driver X Fresh Produce	+**	-***	NS
Company Driver X Intermodal	NS	-***	NS
Company Driver X Passenger	NS	NS	NS
Company Driver X Dry Bulk	-*	-***	NS
Company Driver X Refrigerated	+***	-***	NS

* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$
NS = Not significant

5. DISCUSSION AND CONCLUSION

The purpose of this study was to examine the relationship between organizational flexibility (i.e., use of company drivers or owner-operators) and firm safety performance. Leveraging the organizational flexibility and transaction cost economics literature, we developed a theoretical model of firm size, company drivers, and safety performance. In so doing, we theoretically and empirically tested three core hypotheses about how an organizational flexibility strategy serves an important role in firm safety performance in the US motor carrier industry.

We believe that our study provides important theoretical and empirical contributions to the motor carrier safety literature. Additionally, we point out that use of company drivers or owner-operators is conceptually linked to the concept of organizational flexibility. Our study also offers important managerial and public policy implications.

We now turn to describing the implications of our study's findings.

Our first hypothesis examined the role of firm size in the use of company drivers/owner-operators. The theoretical foundation of our hypothesis was that firms derive economies of scale advantages when pursuing organizational flexibility arrangements. Stated differently, firms that have sufficient financial resources are able to more effectively pursue flexible governance structures.

Large firms have an advantage in doing so because they can leverage their information technology investments to monitor their supply chain partners and employees' behaviors. Technology investments enable the firm to guard against opportunistic behavior. Indeed, we found statistical support for the notion that as firm size increases, firms pursue organizational flexibility structures as measured in terms of the use of owner-operators. The managerial and public policy implication of this finding is that motor carrier firm that are best positioned to respond to capacity changes are those that have the resources to invest in technology solutions to monitor the outsourced partners' behavior.

We also found anecdotal support for our first hypothesis. Through a review of the trade press literature, we discovered that some firms prefer the outsourcing arrangement as a way to avoid vehicle maintenance responsibilities. Larger firms prefer the owner-operator strategy because those firms do not want to bear the responsibility of vehicle maintenance and upkeep (Kilcarr 2015). Our anecdotal data also provide the insight that outsourcing arrangements enable a firm to gain access to modern equipment that can affect product quality and mitigate safety concerns.

We now present the implications of our second hypothesis, which examined the relationship between the use of company drivers and safety performance. We found that the use of company drivers has a negative effect on safety performance. This surprising finding suggests that firms that employ company drivers are possibly not effective at managing and maintaining their fleets. Because profit margins in the industry are small, motor carriers may not adequately allocate their funds to equipment maintenance (Cantor et al. 2015).

Another potential implication of this finding is that motor carriers are not able to rapidly adapt to the proper equipment configurations necessary to safely haul freight for their customers. Moreover, consistent with the TCE arguments presented earlier, firms are not effectively monitoring the operating status of their drivers and equipment, and thus this lack of control results in poor safety performance.

The public policy implication of this study's results is that regulatory changes might be needed to encourage modernization of motor carrier fleets and provide more tools and resources to monitor the behavior of a carrier's drivers and use of owner-operators.

Our last empirical finding concerns the hypothesis that the effect of the use of company drivers on firm safety performance will vary across industry commodity segments. As discussed earlier, the US motor carrier industry has several different commodity segments, which require flexible operating strategies and equipment to safely haul freight.

Firms could be at a competitive disadvantage if they attempt to operate in certain industry segments without acquiring proper equipment and training. Therefore, we believe our empirical findings suggest to managers and public policy officials that more work needs to be done to enforce proper equipment configurations and training so that motor carriers do not place the public in harm's way.

While this study does provide important theoretical insights, there are several opportunities for future research. First, this study is based on a cross-sectional archival dataset. Future research should attempt to collect longitudinal data. In so doing, issues of causation can be addressed. Additionally, future research should employ a case study approach to explore some of the behavioral and environmental uncertainties associated with the decision to use company drivers or owner-operators.

In this study, we discussed the use of information technology among company drivers and owner-operators. Future studies should seek to understand the nature and extent of technology usage among these driving populations.

In conclusion, the US motor carrier industry continues to face a serious shortage of qualified motor carrier drivers. At the same time, the demand for freight transportation continues to grow. Carriers, the commercial driver community, shippers, and regulators need to work together to identify sustainable solutions to ensure continuity of commercial transportation solutions. Hopefully, this study will motivate others to continue research on this important topic.

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