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ORIGINAL ARTICLE

Compensation and crash incidence: Evidence from the National Survey of Driver Wages

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Abstract

Commercial motor vehicle driving is one of the most dangerous occupations in the United States. The production of most trucking services takes places on public roadways, which makes commercial motor vehicle safety a topic of concern for industry stakeholders, supply chain operations, policy makers, and the general public. This study explores the relationship between new employee driver compensation and for-hire interstate truckload motor carrier crash incidence. The results suggest that, all else constant, higher benefits are associated with fewer crashes. While mileage pay rates predict crashes, we find that higher mileage rates can be correlated with either higher or lower crash frequency – depending on the carrier's existing starting pay level. This may be due to pernicious incentives created by piece-rate pay structures, because drivers who have more unpaid non-driving work time may earn a slightly higher mileage pay rate, which only partially compensates them for unpaid labour time. Regardless, these results suggest that compensation is an important predictor of safety and the existing pay practices in the industry may be unsafe. It also suggests that the role of compensation in motor carrier safety performance deserves further exploration with better quality data–especially full documentation of hours of work and pay rates.

Keywords: compensation level; compensation method; economics of industrial safety; industrial/employment relations policy; labour standards; long-distance truck drivers; minimum wage; occupational safety; piecework; safe rates

Introduction

Trucking is critical to the United States (US) economy and by far the most heavily utilised mode of freight transportation in the country, grossing more than USD 75 billion in revenue in 2018 (Day & Hait, 2019). Truck drivers are at the heart of this industry. However, driving is a notoriously low-paying and dangerous job. Empirical evidence suggests that workplace safety deficits are more common in low-paid occupations (Anelli & Koenig, 2021) and unsafe work environments have been linked to health disparities, associated with cost-shifting behaviour, and an increased reliance on social safety nets (Braveman et al., 2011; Lipscomb et al., 2006; Siqueira et al., 2014; Zabin et al., 2004). Because production takes place in the public space, as trucking does, the public also has a stake in occupational safety.

Trucking is one of the most dangerous occupations in the US. According to the Census of Fatal Occupational Injuries (CFOI), the US experienced 5250 occupational fatalities in 2018.

Heavy and tractor–trailer truck drivers alone experienced 831 of them and almost 80% of those came from 'transportation incidents' (U.S. Department of Labor, Bureau of Labor Statistics, 2018).[1] These incidents often affect other drivers too. In fact, non-truck motorists and non-motorist road and byway users typically bear the brunt of the damage in collisions. For example, approximately 5500 non-motorists, such as pedestrians and cyclists as well as non-truck vehicle occupants, were killed in large truck crashes in 2018 (Federal Motor Carrier Safety Administration, 2021).

In 2018, the estimated cost of all large truck and bus crashes was approximately USD 143 billion – roughly twice the trucking industry's gross revenue (Federal Motor Carrier Safety Administration, 2020). While crashes are expensive and industry stakeholders often consider safety performance in their dealings with carriers, the minimum liability insurance requirements in US trucking have remained frozen at USD 750,000 per incident since 1985.[2] That is the same as USD 273,662 in 2022 USD, even as the actuarial cost of even one death has risen to USD 10.5 million (Federal Motor Carrier Safety Administration, 2016). Costs not included in price have to go somewhere, and a substantial fraction of the cost of crashes is borne by the public. Economists call these 'externalities', and because of these, market mechanisms may not generate economically efficient outcomes.

US federal safety regulators have exclusively emphasised downstream safety determinants and solutions. While these are certainly important, neglecting upstream (economic) issues overlooks an important root cause of safety behaviour: economic incentives (Belzer, 2000, 2012a, 2012b; Quinlan, 2001; Quinlan & Wright, 2008; and Viscelli, 2016). Furthermore, despite throwing millions of dollars of regulatory effort at the death toll, the number of fatal large truck and bus crashes continues to rise in the US. The annual number of fatal crashes per 100 million vehicle miles travelled (VMT) increased by 33% from 2009 to 2019 (Federal Motor Carrier Safety Administration, 2021).

This study explores the link between motor carrier compensation practices and crash incidence. As the literature review shows, we are not the first to discover this relationship, but policymakers require regularly refreshed research with new data. US federal trucking safety regulators currently do not track compensation information, so we supplement existing safety data with industry pay package information taken from the 2018 National Survey of Driver Wages (NSDW), produced by the National Transportation Institute (NTI). Ultimately, we find evidence supporting the hypothesis that current piece rate pay practices are unsafe.

Literature

In economics, the employer–employee relationship typically is framed in terms of agency theory. In the standard principal–agent model, the agent bears the disutility of work and the principal captures the benefit. In practice, the principal may not have perfect information about the agent's effort or performance, and this asymmetry creates an opportunity for 'shirking'. To prevent it, the principal's usual options are to adjust the level of compensation, attach it to performance, or both (Oyer & Schaefer, 2010).

Compensating labour at or above the market rate (at an 'efficiency wage') reinforces employees' opportunity cost of losing their jobs and the external level of attraction to their position. This should lead to increased productivity, which empirical research supports. For example, Holzer finds that wages are positively correlated with employee experience, tenure, and productivity (Holzer, 1990). Cappelli and Chauvin find that wage premiums and disciplinary discharges are negatively correlated (Cappelli & Chauvin, 1991). Thus, to the extent that safety performance is important to managers and safety factors are endogenous to labour characteristics, efficiency wages should lead to better safety performance.

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Performance pay encourages productivity by attaching compensation directly to output. Paarsch and Shearer find that piece rate compensation improved the productivity of tree planters in British Columbia (Paarsch & Shearer, 1997), and Lazear found that switching to piece rate pay dramatically increased the average number of windshields installed by workers at Safelite Glass Corporation (Lazear, 2000). However, changing the incentives for a particular set of tasks changes the relative reward for work and can negatively influence performance elsewhere (Holmstrom & Milgrom, 1991). This can invite unintended consequences. Freeman and Kleiner (2005) investigate the decision to move away from piece rates at Big Foot (a large US shoe manufacturer). Despite lower output, Big Foot's profit margins expanded due to lower workers' compensation payments, smaller inventories, and other logistical cost savings.

It has long been recognised that performance pay has the potential to encourage workers to take more risks, cut corners, and overwork. Naturally, these behaviours can be detrimental to employee health and safety outcomes. Recent empirical evidence suggests that employees in jobs with performance pay report being less healthy (Bender & Theodossiou, 2014; Davis & Hoyt, 2020; Kudo & Belzer, 2020), experience higher levels of absence due to illness (Devaro & Heywood, 2017), and are at increased risk for injury (Artz & Heywood, 2015). Notably, these effects appear to be particularly strong for low-income (Davis & Hoyt, 2020) and 'blue-collar' labour (Artz & Heywood, 2015).

Driver compensation and motor carrier safety

Economic theory and empirical research suggest that the level of driver pay should positively predict the calibre of drivers attracted to job postings, driver retention, morale, and safety. Indeed, multiple studies have found evidence linking driver experience (Lin et al., 1993; Monaco & Williams, 2000; Rodriguez et al., 2006), retention (Miller et al., 2017), and compensation to safety (Belzer et al., 2002; Kudo & Belzer, 2019a; Monaco & Williams, 2000; Quinlan & Wright, 2008).

Most over the road (long haul) truck drivers are paid on a piece rate basis. The most common form of this is mileage pay (Burks et al., 2010). As its name implies, mileage pay accumulates only when the truck is moving and often only when the truck is earning revenue. This creates incentives for aggressive driving, falsifying logbooks, and working unsafe hours. The empirical evidence supports this. Piece rate compensation structures have been associated with speeding (Edwards et al., 2016; Hensher et al., 1991), increased fatigue (Williamson et al., 2001), longer work hours, and stimulant use in truck drivers (Thompson & Stevenson, 2014; Williamson, 2007).

Mileage pay also makes drivers' average pay contingent on exogenous variables like traffic, detention, and other forms of non-driving work time. According to the University of Michigan Trucking Industry Program (UMTIP) driver survey, on average, employee drivers reported working 63.2 hours per week (65.7 in the last one-week pay period) and spent a substantial amount of their time doing non-driving work. In their most recent trip, drivers reported spending an average of 5.7 hours waiting and 2.3 additional hours on non-driving labour.[3] Most long-haul nonunion truckload drivers are not paid anything for this time. The more recent NIOSH survey also shows that the median driver still does not receive any compensation for non-driving time (Kudo & Belzer, 2019b). This can create incentives to falsify their Record of Duty Status (logbook) by logging unpaid non-driving work off duty and encouraging excessive work hours. These excessive unpaid hours lead to more regulatory violations and crashes (Belzer & Sedo, 2018; Kudo & Belzer, 2019a). Specifically, with measures of unpaid non-driving work time, Belzer et al. showed that at the mean, drivers worked 0.004 unpaid hours per mile driven, or 3.634 unpaid hours per 906-mile average trip. Multiple regression showed that 10% greater compensation was

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associated with a 9.2% lower crash rate, including a one percentage point lower crash rate attributable to unpaid non-driving labour (Belzer et al., 2002, pp. 64–71).

In their efforts to suppress unsafe driving behaviour, safety regulators in the US have largely focused on supervision and ignored compensation. The most recent evolution of this involves mandatory electronic logging device (ELD) compliance, which went into effect in December 2017. So far, ELDs have shown mixed results. According to the US Department of Transportation Federal Motor Carrier Safety Administration (FMCSA) Motor Carrier Management Information System (MCMIS), total hours of service (HOS) violations fell from approximately 355,000 in 2017 to 298,000 in 2018.[4] At the same time, the total number of unsafe driving infractions remained unchanged between 295,000 and 298,000, and the total number of US DOT reportable crashes rose from approximately 127,000 to 138,000.

Substantial anecdotal evidence suggests that long-haul interstate truck drivers log most non-driving time off duty to conserve hours.[5] Despite the presence of ELDs, drivers can exploit loopholes to bend HOS regulations because they are not required to specify their functional location (such as a shipper or consignee) and activity in the 'remarks' section of their logs.

Fundamentally, two different departments of government – the Department of Labor and the Department of Transportation – define 'work' quite differently. The FMCSA defines work specifically as time during which drivers are responsible for their freight (or passengers) and vehicle. This allows carriers to claim that drivers are not responsible while they wait for loading and unloading, or even while the process is underway, and decline to pay for this time, thereby creating incentives or even imperatives for drivers to log the time off duty, even if they are 'suffered to work' during that time.[6] In contrast, the Department of Labor defines work as all time during which employees work for their employer – including wait time and even sleep time (Belzer, 2020).

The global safe rates movement

Low pay, intense competition, inadequate labour protections, piece rate compensation, and long work hours have led road transport to become one of the most dangerous civilian occupations in the world. Broadly speaking, countries have taken two approaches to deal with trucking safety challenges. One emphasises downstream safety determinants, attempting to manufacture safe outcomes through supervision and intense, often complicated, regulation of driving time and equipment specifications and maintenance. The second approach attempts to change the economic safety incentives drivers, trucking companies, and cargo owners face, primarily through the regulation of pay practices. If economic incentives and economic pressures – compensation and working conditions, and related consequences of precarious work – drive safety and health outcomes, it makes sense to focus on them.

The relationship between truck driver compensation and safety has been studied for decades. Australian research and public policy established the foundation for this relationship with multiple research papers before 1990. A pilot study conducted by Hensher et al. in 1989 found a relationship between remuneration and truck driver safety (Hensher et al., 1989: Hensher & Battellino, 1990). At about the same time, the US Congress asked the General Accounting Office (GAO) to determine whether such a relationship exists. The GAO's data-based approach is looking at financial and operating statistics of trucking companies, in contrast to the interview-based study of truck drivers used in Australia, finding that there is a relationship between safety and truck driver compensation as well as carrier economic health (General Accounting Office – US Congress, 1991). However, the US Department of Transportation rejected the GAO findings and the US research agenda stalled, while the Australian research took the lead.

Hensher et al. conducted multiple investigations into the relationship between truck driver compensation and safety, including examinations of speeding and drug use (Golob & Hensher, 1996; Hensher et al., 1991, 1992). Mayhew et al. followed with studies of subcontracting in trucking and other industries (Mayhew et al., 1997; Mayhew & Quinlan, 1997). In an important inquiry into the causes of truck safety problems in Australia, Professor Michael Quinlan of the University of New South Wales conducted an intensive and wide-ranging study of the underlying cause of Australian interstate truck crashes and established that the primary cause lies in the economic competition that drives the industry. Unlike Australian intrastate trucking, which is regulated by state-level industrial tribunals that issue 'awards' (industry-wide orders for fair remuneration), long-distance interstate drivers were not covered by such awards, leaving them vulnerable to whipsaw by large retail firms that are the Australian trucking industry's biggest customers. Quinlan's report recommended 'safe rates' and a 'chain of responsibility' that holds every participant in the supply chain responsible for a safety plan (Quinlan, 2001, p. 51).

In the US, parallel research on the explicit relationship between compensation and safety began with a contract awarded by the Office of Motor Carriers of the Federal Highway Administration in the mid-1990s. This contract funded the first major systematic US research on what is now known as 'safe rates'. The project's report was the first in the US to establish the general relationship between commercial motor vehicle driver compensation and safety, with a specific focus on trucking (Belzer et al., 2002).

The Australian Parliament passed the first comprehensive national 'safe rates' law in the world: the Road Safety Remuneration Act.[7] The Act mandated the formation of the Road Safety Remuneration Tribunal (RSRT) to implement safe rates awards. In 2013, however, the Labour government lost the national election to the Liberal/National Coalition. The government quickly hired consultants to critique the RSRT (Deighton-Smith, 2019), and it moved to repeal the law in April 2016. An opposing report was submitted (Belzer, 2016), but it did not reach Parliament until the law had been repealed. The RSRT had been in operation about eighteen months.

The movement for safe rates soon shifted to a global stage. The tripartite[8] United Nations International Labour Organisation (ILO) adopted safe rates principles into its guidelines on the promotion of safe and decent work in the road transport sector in 2019. Guidelines 73–82 address safe payments. Guideline 73 states that rates should take into consideration the goals of increasing the sustainability and attractiveness of the industry; guideline 81 recommends that minimum wages for drivers should be set that consider *all* driving and non-driving work time; and guideline 46, part a, recommends that governments should identify and implement measures to better collect and disseminate CMV driver economic data (International Labour Organization, 2020).

The first major effort to implement the emerging ILO agreement developed in South Korea is led by the Korean Public Service and Transport Workers' Union Cargo Truckers' Solidarity Division (KPTU-TruckSol). The Safe Rates System in South Korea passed into law in 2018, and in 2019 the first Safe Rates Committee met to negotiate safe rates. The first negotiated safe rates came into effect at the beginning of 2020 and covered intermodal freight containers and cement. The definition of safe rates in the law, as translated, is:

> The minimum freight rates necessary to ensure traffic safety by preventing overwork, speeding, and overloading by guaranteeing owner–operator truck drivers fair freight rates by adding a fair margin to the safe trucking cost.[9]

The Korean Safe Rates System includes just two segments of the South Korean trucking industry: container hauling and bulk cement. The vehicles used in these segments are

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'special motor vehicles', in the South Korean truck classification system.[10] While the law seems expansive, less than 1% of all freight and special vehicles are covered by the law, and the law covers only about 6.3% of all commercial (for-hire) motor vehicles. The South Korean law focused on owner operators because South Korean governing law provides that each truck driver must provide his own truck but does not control the operating authority or licensing, making truck drivers completely dependent on trucking company owners. The law was temporary, and the government could repeal it at the end of 2022.

The union established a goal in 2022 to extend coverage of the law to the rest of the trucking industry (especially for big trucks) and extend the period of coverage. In 2022, after the election of a conservative government opposed to the Safe Rates law, the union mobilised an effort to get the law extended. This law led to a nationwide strike of truck drivers in June, which ended when the government agreed to extend the law's coverage. While the union will continue to put political pressure on the government, at the time of this writing the law remains in force.[11]

COVID-19 severely affected supply chains, and the trucking component of the supply chain came under the microscope in the US. Consistent with the US Department of Transportation's urging in its 2022 supply chain assessment,[12] Congressman Andy Levin (D-Mich.-09) introduced the *Guaranteeing Overtime for Truckers Act*. This Act would repeal a provision in the 1938 Fair Labor Standards Act, which applies to almost all other production workers, which exempts truck drivers from the 40-hour work week. This provision is often called the 'overtime' provision because the FLSA requires that US employers pay most workers time-and-one-half (a fifty per cent wage premium) for more than 40 working hours per week. The FLSA discourages employers from requiring employees to work excessively long hours, while encouraging employers to hire more workers and create more jobs. Repealing that provision of the law would require trucking companies, for the first time, to record all hours of work under the US Department of Labor's definition of work,[13] which would be the first step towards 'safe rates' law in the US. A similar or identical bill must be introduced into the US Senate, and Senators Edward J. Markey (D-Mass.) and Alex Padilla (D-Calif.) introduced such a bill on September 12, 2022.[14] As of this writing, the bills have not yet moved forward. The bill has a coalition of important public supporters: the International Brotherhood of Teamsters, the Owner Operator Independent Drivers Association, and the Truck Safety Coalition.

Data

This study uses two data sources, the FMCSA's MCMIS and the 2018 National Survey of Driver Wages (NSDW) from the NTI.

MCMIS crash and census file information

The FMCSA is the Federal Government's primary motor carrier safety regulator. MCMIS houses the FMCSA's safety performance record relational database for passenger, non-passenger, and hazmat carriers. Much of these data are public-facing and available at the FMCSA website. This study utilises data from the crash and census files.

Among other things, the census files contain carrier names, operating addresses, operation classifications, hazmat statuses, power unit counts, and driver counts for all carriers under the FMCSA's jurisdiction, filed on the Form MCS-150. All new carriers must submit Form MCS-150 to acquire a DOT number and register with the FMCSA. Carriers must update these filings within 30 days of any demographic changes and, regardless of changes, all carriers must update their filing every 24 months, though examination of the data suggest that many carriers do not.

DOT numbers are unique carrier identification codes assigned by the FMCSA to companies that operate commercial vehicles transporting passengers or freight in support of interstate commerce. They are nontransferable, assigned to only one person or legal entity, and act as a primary key for the MCMIS database. We use these numbers to link NSDW carriers with their corresponding MCMIS information and to aggregate crash reports. Reportable crashes are those in which a vehicle is towed away, somebody is injured and treated away from the scene, or somebody is killed.

The National Survey of Driver Wages employee driver report

The NSDW is a quarterly survey of truckload motor carrier compensation practices for employee drivers and owner operators. The fundamental unit of observation in the NSDW is the 'pay package'. A single carrier may have multiple packages in any given quarter. Typically, pay packages vary by trailer specification (dry van, tank, flat, and temperature controlled), payment type (mileage pay, load pay, tonnage pay, percentage pay, and hourly pay), and/or route structure. The 2018 NSDW contains approximately 1,800 pay packages from roughly 200 unique DOT numbers.

Before linking the NSDW with MCMIS, the data are compressed to the carrier level by DOT number and annualised. Numeric variables are double-averaged, and binary variables are assigned based on whichever status has 50% or more of quarterly observations. Not all carriers are present in the NSDW for all four quarters. Consequently, some observations with only 1, 2, or 3 quarters worth of packages are stretched to define yearly measurements.

The trucking industry is integrated into the economy in several ways, operational data are limited, and trucking operates within a fragmented market. This makes it difficult to analyse the industry as a whole and, consequently, we focus on a critical narrow sector: general and specialised for-hire interstate 'truckload' carriers.

For-hire interstate carriers operate commercial motor vehicles hauling cargo that belongs to other people or businesses, as part of interstate commerce. Carriers often specialise by freight types and may use different equipment. For example, general carriers typically haul materials that can be stored in traditional 'dry boxes', while specialised carriers may handle freight that requires dry tanks, liquid tanks, flat beds, or refrigerated units.

Figure 1 shows that NSDW reports base pay for carriers predominantly in terms of cents per mile. To preserve sample homogeneity, we drop carriers that do not pay by the mile, private carriers, less-than-truckload carriers, carriers reporting multiple trailer types, and carriers with faulty records. This leaves a sample size of approximately 110 firms – the first four navy blue bars.

Broadly speaking, the regression is representative of the NSDW but not representative of the entire population of MCMIS. NSDW carriers are relatively large (see Figure 2) compared with the full population of carriers reported in MCMIS.

Sample descriptive statistics

The Motor Carrier Act of 1935 brought the economic operations of the US trucking industry under the regulation of the Interstate Commerce Commission (ICC). From 1935 to 1980, the ICC used yearly 'Form M' filings to acquire financial and operating data to assist in discharging its mandate. These data were publicly accessible and contained hundreds of financial and operational variables for large (Class 1 and Class 2) interstate motor carriers, including data on compensation for 11 categories of employees. With the dissolution of the ICC in 1995, Form-M was passed to the Bureau of Transportation Statistics and the data releases eventually ended in 2004 (Burks et al., 2004).

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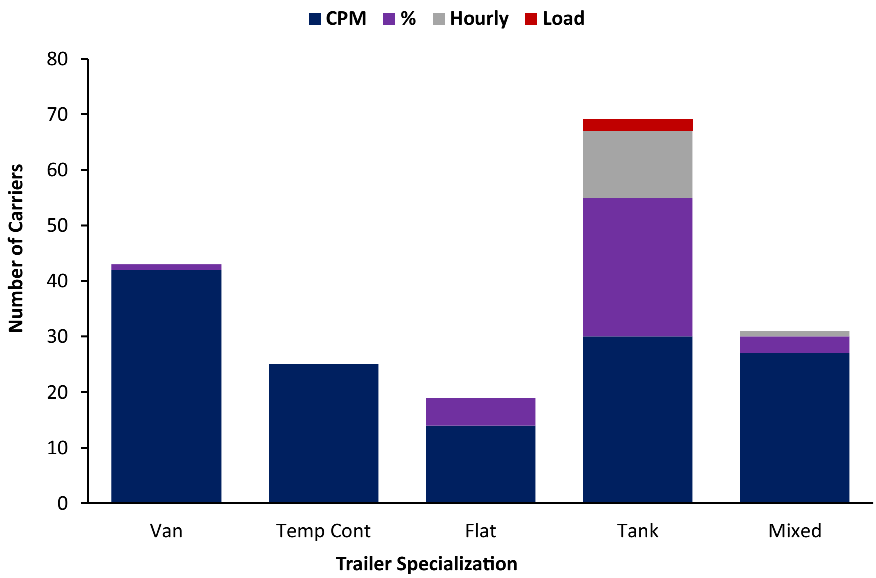

Figure 1. Starting Base Pay Type Frequency Breakdown by Carrier Specialisation for a Driver with 3 years of previous experience.
Notes: CPM ('cents per mile') refers to carriers that pay by the mile; '%' refers to carriers that pay drivers based on the percentage of carrier revenue earned per load; 'Load' refers to carriers that pay drivers a flat rate for each load; and 'Hourly' refers to carriers that pay drivers a fixed hourly rate.

With 'Form-M' gone, MCMIS has become the only source of publicly available trucking industry data. However, it contains very little operational information and, importantly, does not contain *any* compensation data. Because of this, the NSDW presents a unique opportunity to observe pay levels and practices in the industry. See Table 1 for a brief set of sample descriptive statistics and variable definitions.

For comparison, study one in Belzer et al. (2002) uses the 1998 edition of the NSDW, MCMIS, and a supplemental carrier survey to study the effect of solo employee driver compensation on crash incidence. They report an average starting mileage pay of USD 0.4405[15] for drivers with three years of previous experience, an average minimum driver contribution to family health insurance of USD 257, and an average expected life insurance payout of USD 23,884. Driver compensation rates appear to have increased slightly between the 1998 and 2018 NSDW (see Table 1). However, rate increases do not necessarily mean incomes have increased. In fact, the UMTIP and NIOSH surveys suggest that, in per mile terms, real income has fallen. According to the UMTIP survey, drivers' average annual earnings were approximately USD 57,000, average annual VMT was approximately 112,000, so income per mile averaged roughly USD0.51. According to the more recent NIOSH survey data used by Kudo and Belzer, drivers' mean annual income was roughly USD 57,500, average VMT was 115,000, and this equates to roughly an average of USD 0.50 per mile (Kudo & Belzer, 2019a).[16]

Empirical model

We hypothesise that crashes are a function of firm size, exposure, experience, specialisation, and compensation. The primary objective of this study is to investigate the relationship between various types of compensation and safety. Everything else is included as a control.

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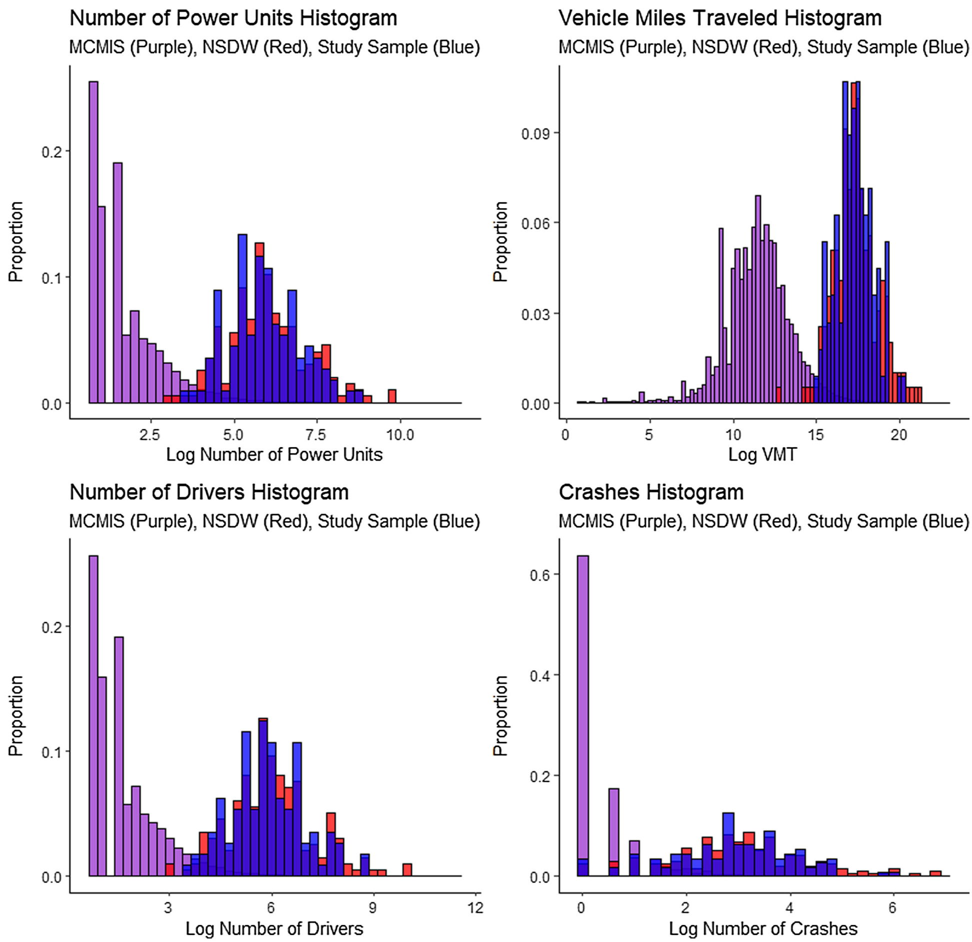

Figure 2. Comparing interstate carriers, to NSDW carriers, to study sample carriers.
Note: The MCMIS sample is included as a population proxy. It consists of all interstate non-passenger carriers that updated their mileage between 2013 and 2019 and was taken from the December 2018 census file. Crash and damages information is taken from the FMCSA's crash files and pertains to incidents that took place during 2018. Data are plotted in log scale to compress outliers. Instead of frequency counts on the y-axis, proportions are used to adjust for the difference in sample sizes ($N_{MCMIS} \approx 200,000,\ \ N_{NSDW} \approx 200,\ \ N_{Study} \approx 100$).

Firm size and exposure

The labour economics literature shows that larger firms tend to receive more applicants, pay higher wages, and spend more on recruiting (Manning, 2011; Oyer & Schaefer, 2010). Carrier size also provides access to deeper financial, human, and physical capital resources that can make safety investment and compliance easier. These characteristics should translate into better safety performance, and this has been demonstrated in the motor carrier safety literature (Cantor et al., 2016). However, due to increased exposure, large firms typically experience more crashes overall. To control for this, we include the number of power units, total VMT, and a team-driving indicator.

The term 'power unit' refers to either a straight truck or the tractor portion of a tractor–trailer combination. Power units are the primary capital investments for truckload carriers and is an important indicator of firm size. Power unit counts will also help control for the number of drivers, as the sample correlation coefficient between power unit and

Table 1. Notation, definitions, and sample descriptive statistics

Notation	Definition	Min	Median	Max	Mean	Std.dev.	Non-reporting
Crashes	Number of DOT report crashes.	1	18.5	377	35.15	53.84	0/112
PU	Total number of power units.	34	347	5750	645.5	845.07	0/112
VMT	Total vehicle miles travelled.	3,580,000	32,999,259	594,318,297	60,793,214	86,663,992	0/112
Team	Indicator for use of team drivers (1 = Yes, 0 = No).	0	0	1	0.3928	0.4905	0/112
OO	Indicator for owner operator use (1 = Yes, 0 = No)	0	0	1	0.0982	0.2989	0/112
Min exp	Minimum hiring experience (months).	0	12	36	11.37	7.5581	0/112
Min age	Minimum hiring age (years).	18	22	25	22.13	1.31	0/112
Van	Indicator for general carrier. This variable is omitted from regression models to avoid perfect multicollinearity.	0	0	1	0.3839	0.48	0/112
TC	Indicator for temperature-controlled carrier (1 = Yes,0 = No).	0	0	1	0.2232	0.41	0/112
Special	Joint indicator for flat or tank carrier (1 = Yes, 0 = No).	0	0	1	0.3929	0.49	0/112
HM	Indicator for hazmat placard (1 = Yes, 0 = No)	0	0	1	0.3214	0.47	0/112
PTO	Starting paid time off for new drivers. This variable was created by adding the number of holidays (divided by seven) to weeks of vacation time.	0	1.732	3.5	1.515	0.66	0/112
CPMA	Average reported starting mileage pay for solo employee drivers.	0.311	0.4447	0.5683	0.4521	0.05	0/112
PPMI	Practical mileage pay indicator (1 = Yes, 0 = No).	0	0	1	0.2842	0.45	17/112
Safe	Safety bonus indicator (1 = Yes, 0 = No).	0	1	1	0.5315	0.50	1/112
SHP	Drivers' weekly out-of-pocket contribution to the (least expensive) single health insurance package offered.	0	34.85	89.33	34.69	17.12	3/112
FHP	Drivers' weekly out-of-pocket contribution to the (least expensive) family health insurance package offered.	0	120	734	131.93	78.74	0/112
COPDL	Value of company paid life insurance.	0	15,000	150,00	20,983	22,661.46	9/112

driver counts is greater than 0.9. This is not surprising because typically one driver operates one truck at a time except when running as a team.

US drivers 'run team' (in Australian parlance, 'two-up') when two drivers cooperatively operate the same truck. Team members are subject to HOS regulations that are similar to those imposed on solo drivers, but they can take their breaks and spend their mandatory off-duty time in the sleeper berth while their co-worker drives. *A priori*, the theoretical effect of teaming on crashes is uncertain. A well-functioning team could very well experience fewer crashes per mile than the average solo driver and vice versa. However, in practice, most of a team driver's weekly break and off-duty time is spent in the sleeper berth. Furthermore, showers, rest stops, meals, and other scheduling aspects of the workday need to be planned around two different schedules. Therefore, teaming may come with more complicated organisational challenges, and this could certainly lead to safety issues. Regardless, teams typically log more miles per power unit and, for this reason, it is an important exposure control.

Experience

Studies have shown that driver age (Cantor et al., 2010) and experience (Lin et al., 1993; Monaco & Williams, 2000; Rodriguez et al., 2006) are important predictors of safety. Unsurprisingly, new drivers and younger drivers appear to experience more crashes. Unfortunately, the average level of driver experience and driver age is not visible in the NSDW. However, we can observe the minimum level of previous experience and minimum hiring age. We include this information in the regression model.

Owner operators

The relationship between trucking companies' use of owner operator contractors and safety outcomes is theoretically ambiguous. On the one hand, to protect their investment, owner operators may have more reason to drive safely and keep vehicles well maintained. On the other hand, ownership can also create greater economic pressure and, therefore, increase crash risk (Belzer, 2018). Furthermore, unlike employee drivers, owner operators are uniquely able to relieve financial pressure by deferring vehicle maintenance. Carriers also may exploit leased drivers to shift operating expenses to their labour force, and this behaviour may reveal poor safety culture and add extra pressure on drivers. While the empirical evidence is mixed, Miller et al. studied a sample of relatively large motor carriers and found that greater subcontractor[17] use was associated with worse safety performance (Miller et al., 2018). This may reflect the fact that such carriers have less control over contractors than companies that rely on employee drivers, or it may reflect safety performance of different trucking subsectors or other confounding and unmeasured factors. However, the extent to which carriers use owner operator contractors is not visible in the public-facing MCMIS data, as it reports the total number of power units used by each carrier, regardless of whether it is owned, term leased, or trip leased. Instead, the presence of owner operator pay packages in the NSDW is taken as indication of their use and included as a control.

Hazmat

To haul hazardous materials, carriers must register with the FMCSA, display hazmat placards when hauling hazardous commodities, and use drivers with hazmat certification. Hazmat loads receive more scrutiny from authorities and hazmat drivers tend be more experienced, which could lead to systematic differences in wage and safety outcomes. We include a hazmat indicator to control for this.

Specialisation

General freight carriers typically operate standard dry vans. Freight that requires something more specific is referred to as specialised cargo (Burks et al., 2010). Specialised trailers typically require more driver attention and skill. They have higher experience requirements and may come with higher compensation. There are three types of specialised trailer designations in the NSDW: 'Flat', 'Tank', and 'Temp Controlled'. We combine flatbed and tank carriers into a single 'specialised carrier' group. We give temperature-controlled carriers their own indicator, and the general freight indicator (dry van only indicator) is left out to avoid collinearity.

Compensation

The NSDW is a compilation of carrier pay packages, so we can only see what is being offered to new hires.

Base pay is reported exclusively in terms of mileage pay – specifically the average reported starting rate for each carrier. Mileage rates typically are paid based on either the mileage associated with the shortest route ('household goods miles' or HHG miles) or the shortest practical route ('practical miles'). HHG miles are defined as the shortest legal mileage a commercial motor vehicle may take to reach its destination, and practical routes are based on the most time and fuel-efficient route. These are not the same, so we have included a practical mileage indicator to control for this. To a first approximation, drivers that pay practical miles, instead of book miles, are paying their drivers more per mile.

The association between mileage pay offers and company safety performance is ambiguous a *priori*. On the one hand, higher rates may allow carriers to distinguish themselves among potential drivers and, therefore, be more particular with their staffing. This should be safety inducing. On the other hand, trucking companies that offer higher rates may simply be doing so to compensate drivers for unpaid non-driving work time, and without information on uncompensated non-driving working time, we do not know the net effect on overall wages per hour worked. As Belzer et al. (2002) suggest, higher wage offers therefore may be associated with worse safety outcomes because drivers work more unpaid non-driving hours, encouraging risky driving behaviour and unsafe hours of work.

Drivers may also receive a variety of benefits and bonuses, such as vacation time, holiday pay, life insurance, retirement packages, and others. Empirical evidence suggests that uninsured workers, in general, are at a higher risk for occupational injury and illness (Siqueira et al., 2014), and that working when it would be appropriate to take time off is associated with increased severity of workplace accidents (Asfaw et al., 2010; Siqueira et al., 2014). Furthermore, the various aspects of compensation are fungible – at least to some extent. For example, in the absence of employer-provided insurance, employees have an incentive to purchase insurance from the marketplace and, therefore, the provision of insurance by the employer should free up a proportional amount of employees' earnings for discretionary use. Thus, it also is reasonable to expect the provision of benefits to have a safety income effect analogous to that of a generic increase in fixed payments. Variables for starting paid time off (PTO), minimum driver weekly out-of-pocket health insurance contributions, expected company paid life insurance payouts, and a safety bonus indicator variable have been included.

Model specification

The dependent variable in this motor-carrier-level analysis is a count of total reportable crashes. Poisson models are the appropriate starting point, but the descriptive statistics for crashes (see Table 1) and its empirical distribution (see Figure 2) present telltale signs

Table 2. DOT Reportable Crash Negative Binomial Regression and Diagnostic Information

	Regression output $\beta(\sigma)$	Elasticity from mean	VIFs
Intercept	−4.1952(2.099)***	—	—
ln **VMT**	0.526(0.122)***	0.53	27.07
ln **PU**	0.394(0.122)***	0.394	24.77
Team	0.102(0.062)*	—	1.67
OO	0.213(0.089)**	—	1.24
Min Exp	0.004(0.005)	0.045	1.74
Min Age	−0.038(−0.029)	−0.840	1.73
HM	−0.103(0.06)*	—	1.33
TC	−0.246(0.08)***	—	1.72
Special	−0.014(0.074)	—	2.1
PTO	−0.107(0.041)***	−0.162	1.57
CPMA	−16.22(5.095)***	0.428	160.95
CPMA^2	18.99(5.781)***		160.65
PPMI	−0.131(0.071)*	—	1.49
Safe	−0.097(0.056)*	—	1.36
SHP	0.003(0.002)*	0.104	1.49
COPDL	−2.279E–06(1.702E-06)	−0.048	1.46
N	90		
$\rho_{\overline{\chi^2}}$	0.00		
ρ_{χ^2}	0.00		
Mc Fadden's Pseudo R^2	0.3191		
Residual Deviance	2469		
Null Deviance	101.69		

Note: Variables names refer to those defined in Table 2, *N* refers to sample size, ρ_{χ^2} is the ρ-value for the global model fit (Wald) test statistic $(H_0 : \beta_0 = \beta_1 = \ldots = \beta_i = 0)$, $\rho_{\overline{\chi^2}}$ is the ρ-value associated with the dispersion test statistic $\overline{\chi^2}$ $(H_0 : \mu = \sigma^2)$, and asterisks indicate statistical significance (10% [*], 5% [**], and 1% [***]).

of over-dispersion. This was ultimately confirmed by a dispersion test (see Table 2) and, consequently, the primary regression specification for this study is the following negative binomial regression:

$$\begin{aligned} \ln(Crashes) = {} & \beta_{Intercept} + \beta_{VMT}\ln(X_{VMT}) + \beta_{PU}\ln(X_{PU}) + \beta_{Team}X_{Team} + \beta_{OO}X_{OO} \\ & + \beta_{MinExp}X_{MinExp} + \beta_{MinAge}X_{MinAge} + \beta_{HM}X_{HM} + \beta_{TC}X_{TC} + \beta_{Special}X_{Special} \\ & + \beta_{PTO}X_{PTO} + \beta_{CPMA}X_{CPMA} + \beta_{CPMA2}X^2_{CPMA} + \beta_{PPMI}X_{PPMI} + \beta_{Safe}X_{Safe} \\ & + \beta_{SHP}X_{SHP} + \beta_{COPDL}X_{COPDL} \end{aligned}$$

where VMT is 'vehicle miles traveled' by carriers' power units (truck tractors); Team is an indicator ('dummy') variable for team operations; OO is an indicator for owner–operator operations; MinExp is the minimum amount of truck driving experience the company will hire; HM is an indicator variable for hazardous materials hauling; TC is an indicator for

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temperature-controlled (refrigerated van) operations; Special is an indicator for specialised (tank and flatbed) operations; PTO is starting paid time off for new drivers; CPMA is average reported starting mileage pay for solo employee drivers, in cents; PPMI is an indicator for practical mileage pay; Safe is an indicator for safety bonus; SHP is the driver's out-of-pocket expense for health insurance; and COPDL is the value of company-paid life insurance (see Table 1 for detailed variable definitions). Estimation was made using the 'glm.nb' command from the MASS library in R. This command utilises the NB2 framework (quadratic/second-order variance structure), which is a standard calibration for modelling over dispersed Poisson processes (Hilbe, 2011).

The usual coefficient of determination ('R^2') is not well defined for generalised linear models (GLMs). In lieu of this, scholars have developed several measures which try to replicate the information content of the traditional R^2 within the GLM framework. For example, Stata reports McFadden's 'Pseudo R^2' by default for most types of GLM models (see Table 2). Broadly speaking, McFadden's Pseudo R^2 and the traditional R^2 can be interpreted in a similar way. However, the maximum value of McFadden's Pseudo R^2 is less than 1 and somewhat opaque. This can make it hard to interpret globally (Cameron & Windmeijer, 1996).

Given the ambiguity of the pseudo R^2, null and residual deviance information has been included as well. Deviance essentially is a GLM analogue to squared error. Residual deviance is defined as twice the difference between the log-likelihood from a saturated model and the fitted model. Similarly, null deviance is defined as twice the difference between the log-likelihood from a saturated model and the null model (the intercept only model). In general, models that eliminate a substantial amount of null deviance can be interpreted as well fitting (Cameron & Windmeijer, 1996). As Table 2 shows, this model eliminates approximately 95% of residual deviance and, for McFadden's, has a reasonably high pseudo R^2.

Canonical negative binomial regression equations have a semi-log structure. This means that coefficients correspond to percentage changes in the dependent variable. For non-logged first-order terms, this is well approximated by $100\beta_i X_i$. That makes indicator variable coefficients easy to interpret, but non-logged non-binary variable coefficients are somewhat opaque.

For ease of interpretation, we have transformed the non-binary variable coefficients into elasticities from the mean and reported them in Table 2. Logged variables create constant elasticities in these sorts of models and, thus, their elasticities from the mean are equal to their coefficient values. First-order variables have linear elasticities of the form $\beta_i X_i$ and, from the mean, $\beta_i \overline{X_i}$. Since all independent variables are non-negative here, the sign of first-order elasticities is determined exclusively by their regression coefficients. On the other hand, higher-order variables retain their polynomial structure in elasticity form and, because of this, both the size and sign of their elasticity can vary. In these cases, simple elasticities from the mean may conceal potentially important information and, often, it is better to observe all of them (see Figure 3).

Table 2 also contains generalised variance inflation factors (GVIFs) computed based on the work of Fox and Monette (1992). GVIF coefficients can be interpreted using the same rules of thumb as standard variance inflation factors. For the most part, the GVIFs for this model are relatively well behaved. After all, the quadratic portion of the model should be highly collinear by design. Furthermore, the magnitudes associated with VMT and power unit counts are not surprising. For obvious reasons, these variables are highly correlated and, since they are only controls, this does not concern us.

The NSDW only contains information for approximately 200 carriers, and fewer than 100 of those can be used in regression analysis due to missing data and other flaws. Consequently, standard errors are predisposed to be high, options for model specification are limited, and the model output may be sensitive to resampling from the population.

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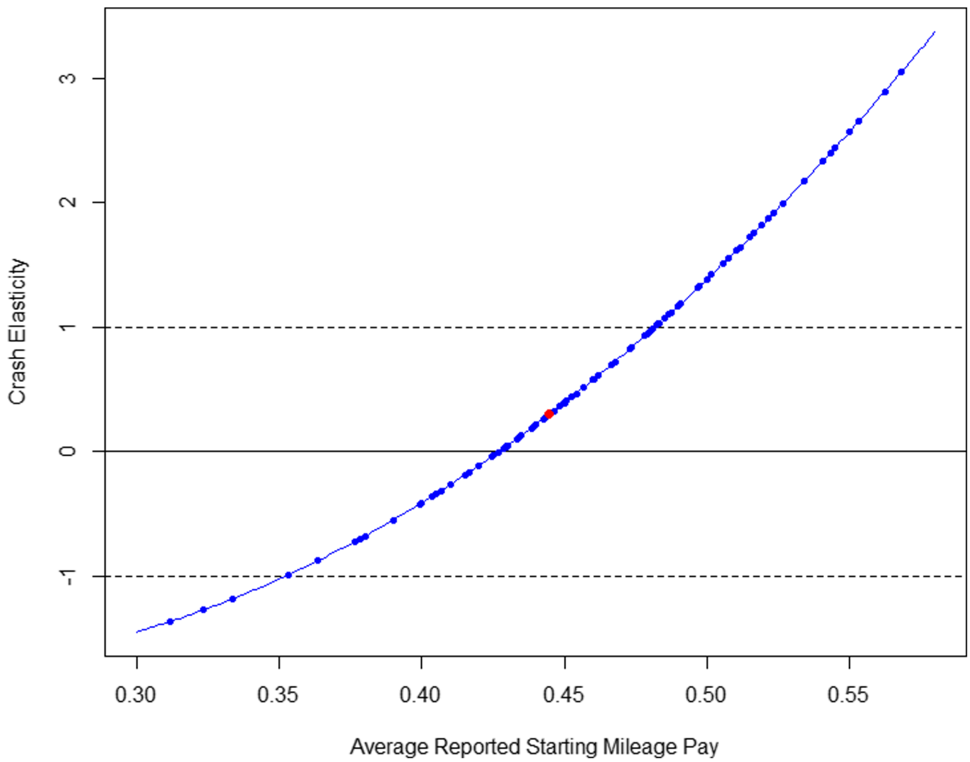

Figure 3. Elasticity of CPMA by mileage rate
Note: Points refer to carriers, and the red point indicates the median carrier.

Results

The primary purpose of this study is to explore the relationship between compensation and crash incidence at the carrier level. Given the sample size, standard errors for compensation variables are relatively strong and their inclusion does appear to improve model fit.

As expected, the coefficient for PTO is negative. All else constant, the model predicts that a 1% increase in starting PTO is associated with 0.162% fewer crashes. For a representative carrier, a 1% increase in PTO equates to approximately 2.5 hours, and a 0.162% reduction in crashes corresponds to approximately 0.057 fewer crashes. This means that every two days of additional PTO is associated with roughly one less crash for each carrier.

The practical mileage pay indicator (PPMI) coefficient is negative. Practical routes emphasise highway driving as much as possible and, therefore, bypass the hazards of local/urban roadways. They are often faster, easier for drivers to understand, easier on the truck, and introduce fewer potential conflicts per mile. Because they are faster and the driver is paid by the mile, the driver's effective hourly pay rate is correspondingly higher. All else constant, offering practical mileage pay is associated with approximately 13% fewer crashes. For the average carrier, that is roughly 4.5 fewer crashes.

The safety bonus indicator (Safe) coefficient is negative. This is unsurprising. Safety bonuses directly reward safe driving and, of course, people respond to incentives. All else constant, the presence of a safety bonus is associated with approximately 9% fewer crashes. For the average carrier, that is roughly three fewer crashes.

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The coefficient for drivers' weekly out-of-pocket health insurance premiums (SHP) is positive. According to the model, a 1% higher insurance premium is associated with 0.104% more crashes. For the average carrier, this is equivalent to approximately USD 0.35 and 0.036 more crashes. In other words, every additional USD 10 of out-of-pocket health insurance premiums is associated with approximately 1 fewer crash. The coefficient for company paid life insurance benefits (COPDL) is negative. The effect is small and statistically insignificant, however.

All variables in the model are crash inelastic at their mean. Even so, the expected cost savings of changes in compensation can still be substantial because the cost of crashes is high. To illustrate, assume the probability of a fatality occurring is uniformly distributed among reportable crashes. Since 2.6% of carrier reportable crashes have at least one fatality, the expected fatality reduction of two extra days of new employee PTO would be at least 0.026 deaths. According to the DOT, the 2018 value of a statistical life was approximately USD 10.5 million (Federal Motor Carrier Safety Administration, 2016). Using this figure, the expected savings associated with 0.026 fewer deaths is almost USD 275,000. This calculation illustrates the fact that small changes in carrier pay practices can elicit big casualty cost savings.

The relationship between average starting mileage pay (in cents per mile) and crashes is non-linear, upward sloping, and switches signs near the median rate (see Figure 3). This means that higher starting mileage pay is associated with fewer crashes for low-paying carriers only and more crashes for high-paying carriers. The model places the threshold between safe and unsafe rates at approximately USD 0.43 cents per mile. Since the average starting mileage pay is USD 0.45, its elasticity from the mean is positive and suggests that a 1% increase in mileage pay corresponds to approximately 0.428% more crashes. However, as Figure 3 shows, a large portion of the sample actually has a negative elasticity.

Discussion

With the exception of company paid life insurance, which is nearly significant even with the small 'n', all elements of fixed compensation are significant and suggest that higher compensation is associated with fewer crashes. These findings reinforce decades of empirical work, in the US and abroad, which demonstrates that truck driver compensation and safety are related. This is important, because, despite substantial empirical evidence, this remains a contentious issue in the US.

Below average mileage rates have a negative crash elasticity. This suggests that low-paying carriers could improve their safety performance and economic performance (Faulkiner & Belzer, 2019) through better pay. On the other hand, above average mileage rates have a positive crash elasticity. However, we suspect that this reflects the confounding influence of unpaid work time and, importantly, that these rates are not actually indicative of 'better pay'. When criticised for not paying for non-driving work time, carriers frequently claim that they offer drivers higher mileage rates to offset exposure to it. This is unsafe. Higher mileage rates increase the opportunity cost (the economic pressure) of delay for drivers, which gives them a greater incentive to falsely log off duty and incentivises unsafe driving behaviour in an effort to 'make up for the loss'. Consequently, we expect that including, and, therefore, controlling for, non-driving/unpaid time would result in negative mileage rate crash elasticities. Empirical evidence supports this. For example, Belzer et al. (2002) supplements data from the 1998 NSDW with their own motor carrier survey and, in doing so, gather information on work time. All else constant, they find that higher mileage pay is unambiguously safety inducing and, importantly, that unpaid time has a (very strong) positive relationship to crash incidence.

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Piece rate compensation schemes also transfer costs of delay onto drivers. In a 2018 study, the Office of the Inspector General (OIG) of the US Department of Transportation estimated that detention is associated with a total reduction in for-hire truckload driver annual earnings of between USD 1.1 and 1.3 billion 2013 USD or USD 1281 to USD 1534 per driver (Office of the Inspector General, 2018).[18] This is a hefty reduction in delay cost for carriers, which diminishes their incentive to prevent cargo owners from freeriding on drivers' time. This is unsafe. The OIG estimated that a 15-minute increase in average dwell time[19] is associated with one additional crash per 1,000 power units, which, using 2013 crash data, works out to roughly 6,500 more crashes for the year. They also found that every 5% increase in the share of loading and unloading stops where drivers experienced detention[20] is associated with 5% more crashes (Office of the Inspector General, 2018).

Despite the empirical evidence that pay is an important predictor of safety and, therefore, a potentially useful policy lever, regulatory authorities in the US simply do not collect longitudinal data on trucking compensation practices or work time (Panel on the Review of the Compliance, Safety and Accountability (CSA) Program of the Federal Motor Carrier Safety Administration, 2017).

Study contribution

Many of the previous studies on the US trucking industry were done at the driver level (Kudo & Belzer, 2019a, 2019b) use annual income divided by VMT as a proxy for mileage pay (see Kudo & Belzer, 2019a, 2019b; Monaco & Williams, 2000), focus on a single carrier (see Belzer et al., 2002; Rodriguez et al., 2006), or incorporate measures of unpaid time (see Belzer et al., 2002).

Annual income divided by VMT is different from mileage rates in some important ways. For example, unpaid time is already priced into annual income and, therefore, one would expect the correlation between driver income and crashes *ceteris paribus* to be negative. Without controlling for unpaid time, higher mileage rates may not actually yield higher effective hourly labour rates, and this introduces the potential for positive correlation to crashes.

We are unable to observe unpaid time because we could not survey the NSDW carriers, as a condition in the contract selling us the data. This complicates the relationship between mileage pay and crashes in our empirical model. On the one hand, low mileage rate crash elasticities are predicted to be negative. This is important, because it suggests that some carriers may be free-riding on safety and, furthermore, intense competition from them can pressure otherwise highroad carriers to cut corners too. On the other hand, higher mileage rate elasticities appear to be positive. We suspect this is due to carriers using mileage pay to compensate drivers for unpaid time and, consequently, is not an artefact of higher pay but instead hides a significant safety risk. This is important, because it suggest that safety performance could be improved by explicitly paying for non-driving work.

Finally, economic data are hard to come by in the (US) trucking industry and, despite its modest sample size, the NSDW is perhaps the most detailed firm-level compensation information available. Consequently, this is a unique opportunity to observe the safety dynamics of the pay offers being made to thousands of for-hire interstate truckload drivers. Furthermore, despite an increasingly well-documented link between pay and safety, safe rates are still a contentious proposition in many political arenas. Thus, it is useful to have as much supporting evidence on record as possible.

Conclusion

The results of this analysis suggest that carrier pay practices are unsafe. The manifestation of this likely depends on a delicate balance between driver experience, mileage pay levels, non-driving pay, and unpaid time.

Piecework pay schemes (prevalent in truckload and universal in the NSDW dataset) offload the risk of delay onto the driver, encourage cargo owners (shippers and consignees) to waste driver non-driving work time by treating truck driver loading and unloading and waiting time as valueless, can encourage more aggressive driving behaviour, and encourage drivers to supply labour off the clock. This leads to crashes.

To the extent that safety costs are externalised and labour markets are not perfectly competitive, carriers face insufficient incentives to pay for safety. This underscores the need for expanded data collection efforts and safe rates regulations. To achieve safety, FMCSA could implement the recommendations from the 2017 Panel report *Improving Motor Carrier Safety Measurement*. The report recommended that the FMCSA collect compensation data from trucking companies and incorporate measures of non-driving work time, which would implement ILO guideline 46.

Results reported in this paper also suggest that drivers should be explicitly paid for all their time, to avoid the risk estimated by the OIG report on detention time. This would conform to ILO sustainable payment guidelines (ILO guidelines 73 – 79).

This research also supports the effort to eliminate the interstate truck driver exemption from the FLSA and realign the Department of Transportation's definition of work with that of the Department of Labor. This would eliminate a legal loophole that forces drivers to log wait time and both load and unload time off duty. It also would cause carriers and cargo owners to internalise more of the risk of certain forms of non-driving time (detention, wait times, and loading and unloading time) and place greater cost pressure on shippers and receivers to avoid it.

Consistent with the US Department of Transportation's urging in its 2022 supply chain assessment,[21] the US House and Senate could pass bills to repeal the interstate trucking overtime pay exemption in the Fair Labor Standards Act. Closure of this loophole would help repair what has long been a broken labour market and ensure that labour market competition is efficient across industries.

To the extent that piece rate pay structures are a source of crash risk, a 'lower-powered' wage structure, such as hourly pay for all work, or at least hourly pay for non-driving time, would likely be safer. Electronic logbooks and extensive intrusive surveillance of drivers now make shirking extremely difficult anyway (Levy, 2015).

Since this would involve broad-based changes in regulatory policy, individual carriers would not face competitive disadvantages for being safe. Paying drivers for all their time will force competitive shippers to become more efficient to reduce costs associated with wasted trucker resources, and that greater efficiency will offset the cost of full compensation. Moreover, commercial vehicle drivers share the risk of unsafe driving with civilian motorists. One way or another, society will have to pay for safety. The question is, how should we split the check?

Notes

1 The CFOI classifies events using the BLS's Occupational Injury and Illness Classification System (OIICS). According to the OIICS manual, the designation 'transportation incident' covers events involving transportation vehicles, animals used for transportation purposes, and powered industrial vehicles or powered mobile industrial equipment in which at least one vehicle (or mobile equipment) is in normal operation and the injury or illness was due to collision or other type of traffic incident; loss of control; sudden stop, start, or jolting of vehicle.

2 United States Code of Federal Regulations Title 49 part 387.9.

3 Non-driving time typically involves loading, unloading, safety checks, maintaining logs and shipping paperwork, route planning, and waiting.
4 As discussed below, if drivers log off duty when performing non-driving duties, rather than logging this time on duty, they can violate the spirit of the HOS regulations without recording work that might otherwise trigger violations, making it appear that they are more compliant with the regulations than they are.
5 One of the authors of this paper provides expert witness testimony to US courts and has seen ample evidence from logs that this practice is commonplace and even encouraged or required by motor carriers.
6 See https://webapps.dol.gov/elaws/whd/flsa/hoursworked/sufferpermit.asp for a definition of 'suffer or permit to work'.
7 https://www.legislation.gov.au/Details/C2012A00046
8 Including representatives from workers, employers, and governments.
9 Article 2.13, Trucking Transport Business Act.
10 Motor Vehicle Management Act. Korean link: https://www.law.go.kr/lsSc.do?section=&menuId=1&subMenuId=15&tabMenuId=81&eventGubun=060101&query=%EC%9E%90%EB%8F%99%EC%B0%A8%EA%B4%80%EB%A6%AC%EB%B2%95#undefined
11 For a more detailed analysis, this white paper was submitted to the South Korean National Assembly:
'Review of the South Korean Safe Rates System'. Submission to the National Assembly Committee on Land, Infrastructure and Transport, Republic of Korea, April 2022. https://www.michaelbelzer-saferates.com/_files/ugd/cacb0e_17ac3be1d5a146a78bb29500c662f2bc.pdf?index=true
12 President Biden's Trucking Action Plan, embedded within a supply chain initiative, aims to solve the truck driver recruitment and retention problem that has plagued the trucking industry for 35 years. See especially item #40 in US Department of Transportation. 2022. "Supply Chain Assessment of the Transportation Industrial Base," Freight and Logistics. Washington: US Department of Transportation, 104. This recommendation urges the US Congress to amend the Fair Labor Standards Act to fully include truck drivers.
https://www.transportation.gov/supplychains.
13 See https://andylevin.house.gov/sites/evo-subsites/andylevin.house.gov/files/evo-media-document/041322%20GOT%20Truckers%20One-Pager.pdf. For the language of the bills, see: https://www.congress.gov/bill/117th-congress/house-bill/7517 and https://www.congress.gov/bill/117th-congress/senate-bill/4823.
14 US Senate Bill (S.4823 — 117th Congress (2021–2022). https://landline.media/truckers-overtime-bill-introduced-in-senate/
15 As noted above, we use 2018 US dollars throughout, unless otherwise indicated.
16 All inflation adjustments were done using the all-item Consumer Price Index for All Urban Consumers produced by the US Department of Labor, Bureau of Labor Statistics (2020). This was accessed via the Federal Reserve Economic Database (FRED), published by the Federal Reserve Bank of St. Louis.
17 Miller et al. distinguish between independent owner-operators that operate on their own operating authority and contractors that operate on a motor carrier's authority.
18 This study was based on 2013 data, provided by the Virginia Tech Transportation Institute, as part a 2014 study of detention time by FMCSA. Currency values are expressed in nominal terms (i.e. 2013USD).
19 Dwell time is the total amount of time a driver spends waiting at a facility.
20 The amount of dwell time necessary for drivers to declare detention status can vary from carrier to carrier. However, it usually is about 2 hours simply because that was the standard during the regulated era that ended in 1980. In their report, the OIG defined detention time as dwell time in excess of 2 hours, following that obsolete standard from before 1980.
21 President Biden's Trucking Action Plan, embedded within a supply chain initiative, aims to solve the truck driver recruitment and retention problem that has plagued the trucking industry for 35 years. See especially item #40 in US Department of Transportation. 2022. 'Supply Chain Assessment of the Transportation Industrial Base', Freight and Logistics. Washington: US Department of Transportation, 104. This recommendation urges the US Congress to amend the Fair Labor Standards Act to fully include truck drivers.
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